Teaching Web literacy in primary education

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Teaching Web literacy in primary education

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"Is de computer voor ouderen in de eerste plaats een bron van informatie, voor tieners is het een sociaal apparaat met al zijn tentakels in het wereldwijde web. Boschma: 'Deze generatie is de eerste voor wie de computer echt helemaal vanzelf spreekt en de gevolgen zijn revolutionair. Ze zijn echt compleet anders dan wij.' De schrijvers zijn optimistisch. 'Wij zijn gewend lineair te werken. Zij plukken overal wat vandaan.' De jongste generatie is daarom wel de knip- en plakgeneratie genoemd, achterbankgeneratie ook en Fox Kids. Boschma: 'Allemaal negatieve etiketten, samengevat onder de drie G's: genot, gemak en gewin.' In dit boek wordt daarom de Generatie Einstein juist grote kwaliteiten toegedicht: ze laat zich geen knollen voor citroenen verkopen."
(citaat uit een interview met de schrijvers van het boek 'Generatie Einstein', *de Volkskrant*, 22-6-2006).

"Kinderen tussen 0 en 13 jaar oud kunnen vanaf vandaag met hun eigen browser het net op. Met de Surfsleutel, zoals de kindveilige toegangspoort genoemd is, krijgt geweld of porno geen kans, zeggen de makers. […] ViPER (11), vaste gast bij de website hackersforhackers.org, zit er niet op te wachten. 'Ik surf liever met Mozilla, dan kan ik alles bezoeken wat ik wil […] Als kinderen willen, kunnen ze die surfsleutel heus wel *hacken*.' "
(de Volkskrant, 21-4-2004).

"Wat Selie wil zeggen, is dat scholieren voor hun werkstukken de informatie van internet klakkeloos overschrijven. 'Ze plukken her en der wat van het net en denken niet na over het verband', klaagt hij. Een boek lezen waarin de verbanden wel worden uitgelegd, zit er meestal niet in. 'Ik denk vaak, snappen ze wat er staat?' De werkstukken worden steeds meer een product van de zapcultuur, vindt Selie. Het kost hem de grootste moeite leerlingen kritisch te krijgen over hun eigen producten."
(uit een interview met Alfons Selie, docent geschiedenis en CKV, Spinoza Lyceum Amsterdam, *de Volkskrant*, 19-4-2006).

"[…] Als ik de klaagzang van de heer Selie in het artikel lees, vraag ik mij af of hij oorzaak en gevolg wel goed voor ogen heeft. Hij heeft de indruk dat scholieren de verbanden van begrippen niet doorhebben. Moeten we dat deze jonge mensen zo sterk aanrekenen? Is het niet bij uitstek de verantwoordelijkheid van de school om jongeren te leren kritisch, betrouwbaar en verstandig om te gaan met informatie en kennis die zij krijgen aangereikt?"
(citaat uit een ingezonden brief in de Volkskrant, 22-4-2006).

"We zijn op het gebied van nieuwe media nog maar beginnelingen, meent Gerrits, en het is zijn vak mensen daarin wegwijs te maken. Nieuwe technologieën zijn het probleem niet, denkt hij, die komen er wel. Maar nieuwe technologieën baren nieuwe media en die brengen weer nieuwe vormen van informatie met zich mee. 'Het is belangrijk dat we onze weg vinden in de *overload* aan informatie en de manieren waarop die tot ons komt. We moeten leren wanneer we wát gebruiken. De grootste uitdaging ligt in het zinvolle gebruik van de technologie. […] [Gerrits] heeft een wens voor zijn zoon: dat hij op school beter leert met nieuwe media om te gaan dan de huidige generatie. 'Kinderen het computerlokaal insturen met de opdracht "zoek maar op internet" is onverantwoord.'"
(citaat uit een interview met Han Gerrits, hoogleraar E-business en IT industry, *de Volkskrant*, 20 mei 2006)

Whereas the computer is primarily a source of information for older people, for teenagers it is a social device, with all its tentacles in the worldwide web. Boschma says, "This generation is the first one for whom the computer is completely normal. And the consequences of that are revolutionary. In this respect, young people really are different from us." The authors are optimistic. "We are used to thinking linearly, but they pick and choose from anywhere." For that reason the youngest generation has been called the cut-and-paste generation, as well as the back seat generation, and Fox Kids. As Boschma says, "These are all negative labels, which can be summed up as 'enjoyment, convenience and gain'. By contrast, this book attributes great qualities to the 'Einstein Generation': "They are unlikely to buy a pig in a poke".

(translation equivalent of the original expression taken from an interview with the authors of *Generatie Einstein*; *de Volkskrant*, 22 June 2006).

"Children between the ages of zero and 13 'will from today be able to surf the Web with their own browser. With the 'surf key', as the child-safe portal is called, violence or pornography do not get a chance, say the manufacturers. […]. ViPER (11), a regular guest on the hackersforhackers.org, is unconcerned. "I prefer surfing with Mozilla; it enables me to visit whatever site I like […] Children who want to will certainly be able to hack into the surf key."

(de Volkskrant, 21 April 2004).

"What Selie is saying is that pupils just copy their assignments verbatim from the web. "They pick various things from wherever they can find them without thinking about the connections", he complains. Reading books in which the connections are explained, is usually dispensed with. "I often ask myself, Do they understand what it says?" Selie believes assignments are increasingly becoming the products of the zapping culture. He has the greatest trouble getting his students to develop a critical attitude towards their own work."

(auotation from an interview with Alfons Selie, a teacher of History, and Cultural and Artistic Education at the Spinoza Lyceum in Amsterdam; *de Volkskrant* 19 April 2006).

"Reading Mr Selie's litany in the article, I wonder whether he might be confusing cause and effect. He is under the impression that students do not understand the connections between concepts. But are they to be blamed for that? Is it not preeminently the school's job to teach young people to handle the information and knowledge they are provided with in a critical, reliable and sensible manner?"

(Quotation from a letter-to-the-editor in de Volkskrant, 22 April 2006).

"We are still beginners when it comes to the new media Gerrits believes, and it is his job to get people to know their way around. New technologies are not the problem, he believes. They will always be there anyway. The point is that new technologies bring new media with them, which, in turn, generate new forms of information. "It is important for us to find our direction in the overload of information and the manner in which that overload finds its way to us. We will have to learn when to use what. The greatest challenge is how to use technology sensibly. [….] [Gerrits] has one wish for his son: that he may learn how to handle the media in better ways than the present generation. "It is irresponsible to send children to a computer room with the instruction to "search for the solution on the web".

(Quotation from an interview with Han Gerrits, Professor of E-business and IT Industry; *de Volkskrant*, 20 May 2006)

Introduction

General introduction

1_ Children and the Web

The quotations in the box on pages seven and eight offer some illustrations of the widespread use of the Internet by children and teenagers, as well as the attention the subject receives in the popular media. Positive and enthusiastic comments on students' Web skills and the possibilities of the Web for learning alternate with rather defeatist remarks or warnings about the dangers of the Internet for young people and their inability to cope with the difficult aspects of the Web.[1] New media such as the Web are either seen as an opportunity or as a threat. There seems to be a mutual lack of understanding between the optimists and pessimists; the former trusting children's ability to acquire new technology skills while blaming teachers and parents for their own lack of Web skills and falling quite hopelessly behind, the latter emphasizing the risks involved in children's use of the Web and their lack of skills in coping with such risks. In other words, the Einstein generation versus the copy-paste generation. Such a 'trust versus anxiety' antithesis is also discernible in the ways in which primary education deals with the Web as a new information resource. Primary school practices present a mixed picture, some schools choosing to restrict students' Web use, others leaving students free to use the Web as they wish and yet others devoting time to the specific teaching of Web skills. Formally, schools have a great deal of freedom in the way they attend to using the Web in practice; in the 'Herziene kerndoelen basisonderwijs' [renewed primary school core targets] learning to use new digital resources is only mentioned in two subclauses regarding the 'Kerndoelen Nederlandse taal – schriftelijk onderwijs', without further elaboration (SLO, 2006).

Recent Dutch research into Internet use by children and teenagers offers some background figures. Almost all Dutch children aged between 10 and 14 use the Internet, while 95% have an Internet connection at home. Children use the Internet primarily for instant messaging, playing online games, searching for information and downloading music. Especially MSN messenger is widely used by both girls and boys, mostly for chatting with friends (Meerkerk, van den Eijnden & van Rooy, 2006). 'Multitasking', using various media simultaneously, is a common, and growing, phenomenon among young people (Qrius, 2006). Research shows that many children, already at a young age, have negative experiences on the Internet, varying from chatting with strangers who are not what they appear to be to bullying

[1] Especially in Dutch usage, the terms Internet and Web are often used interchangeably. Officially, the Internet is a physical collection of interconnected computers and computer networks; the Web is an interconnected set of documents and files linked together by hyperlinks. This thesis deals with the Web, but when referring to Dutch sources, the terms Internet and Web may be used with the same meaning.

through MSN (e.g., Valcke, Schellens, Van Keer & Gerarts, in press). However, figures about online bullying vary between 23% and 41%, depending on the age of the research group and the definitions used (Van den Eijnden, Vermulst, van Rooy & Meerkerk, 2006). In addition, 60 to 75% of the children aged between 11 and 15 years report positive experiences on the Internet, such as getting someone's support or making new friends. A similar mixture of positive and negative experiences is also reported by Valkenburg & Peter (in press), who conclude that Internet communication with strangers accounted for a negative effect on adolescents' well-being, while communicating with friends through the Internet showed a positive influence on their well-being.

Research into Internet use at Dutch schools shows that approximately one-third of students aged between 10 and 14 rarely, if ever, use the Internet at school. Students also use their home computers more often for school assignments than their school's computers. Almost 70% of the primary school students and 50% of secondary school students are of the opinion that they receive useful advice from teachers regarding searches for information on the Web. Almost 25% of the students indicate that teachers are rarely, if ever, aware of students copying information from the Web and pretending it is their own text (IVO/Kennisnet Ict op school, 2006). Recent research into the use of Internet in the classroom (KPN/Blauw Research, 2005) mentions the teachers' need for supporting students on Internet use, but only refers to safety risks and the need for teaching safe Internet use. Supporting students' use of the Web for knowledge construction is not explicitly mentioned. There is reason to provide such support, since 82% of Dutch secondary school students rarely, if ever, check the correctness of Web information (Motivaction/ Malmberg, 2006). They assume everything on the Web is 'true'. Only 4% of the students use library books when searching for information. The preferred Web search strategy is using Google. Teachers often assume that students' general computer skills also mean that they have sufficient information skills at their disposal (Ten Brummelhuis, 2006).

2_ Education and the Web

With respect to the use of the Internet at school and the support of students' use of the Internet, it may be concluded that two broad issues deserve attention. First, there is the issue of students' safety, privacy and well-being on the Internet. Students must learn how to protect their privacy and learn about the risks involved in meeting people through the Internet. They must also be made aware of the impact of 'net-bullying'. Secondly, there is the issue of students using the Web as an information resource. The Web may be viewed as the modern version of the school

library book: even young students use the Web as an information resource when writing school papers, the same way they used library books before the introduction of the Web. However, the Web differs from printed resources in many ways. It is also an educational tool that differs from most other tools used in the classroom in that it is widely used by students outside the classroom. Most students also learn to use the Web at home. With regard to broader Internet skills, students' use of the Internet at home appears to contribute more to these skills than their Internet use at school (Kuhlemeier & Hemker, 2005).

In this thesis, the focus is on the second issue: how to support students in (primary) education in using the Web as an information resource. The study of the Web as a new information tool may be situated within recent views on ways in which knowledge is constructed (constructivism) as well as on active and independent learning. When exploring the concept of 'new learning', Simons, Van der Linden & Duffy (2000) mention as one component of new learning, new kinds of learning outcomes, including learning and thinking skills. The authors mention the need for such skills because of the current increase in information that makes a focus on skills preferable: "It is more what people can do with information than the information itself that becomes important. Finding one's way in the growing body of knowledge becomes more important than having many factual details in memory" (p. 2). With regard to the science curriculum in secondary and higher education, Beishuizen (2004) pleads for a focus on inquiry learning within communities of learning in which students are seen as autonomous knowledge constructors. 'Learning to do science' is one of the goals of inquiry learning in which the use of information resources has an obvious place. From a sociocultural viewpoint, Van Oers (2006) criticizes the current tendency among educationalists toward an 'availability ideology': the idea that the availability of information is sufficient for meaningful learning to take place. By contrast, he argues that education must prepare students for citizenship in an information society; however, not merely by making information available but by teaching students to reflect critically on that information with a view to one's own information need as well as the value of the information in a broader social context. Bereiter (2002) also concludes that the ability to access information is not what knowledge construction in current society is about. Gaining insight into the function of knowledge as well as the ability to use and reflect on information are of primary importance. Wells (1999; 2000) connects such ideas with educational practice in the concept of 'community of inquiry'. In such communities, students construct meaningful knowledge together with help of collaborative inquiry activities that are connected with their own experiences. All these viewpoints underline the

necessity of teaching students specific skills and strategies to deal with the Web as a new and potentially valuable information resource.

3_ General research problem and research questions

The research presented in this thesis has a certain history. In the years between 2000 and 2002 researchers from the Vrije Universiteit worked together with primary schools and teacher educators on a practice-based research study into Web use in education. The five participating schools were looking for ways of designing inquiry activities in the upper grades and of incorporating the Web into these projects in useful and meaningful ways. The evaluation of the project showed that most teachers had problems with such Web use as well as with supporting students with regard to such use. Although the students presented nicely composed and rather sophisticated papers, the teachers doubted their learning gains. Students simply copied and pasted a great deal of Web information, did not know where they had found their information, and appeared to put limitless trust into all Web information. When asked, the students stated that they liked to use the Web because of its convenience: the Web could easily be accessed at home and was never lent out. Moreover, the Web was looked at as 'something easy', providing the required information after a couple of mouse clicks (Kuiper & Volman, 2002).[2] Apparently, meaningful use of the Web required a more systematic and focused approach than was offered in this relatively short project.

These outcomes gave rise to more profound questions concerning the conditions under which the use of the Web as a learning tool in primary education might contribute to students' knowledge construction. Soloway & Wallace already formulated such reserve ten years ago in a thought-provoking article, questioning the suitability of the Web for student inquiry: "Given the current tools, organization, and content on the Web […] searching the Web may well not be an educationally productive activity." (p. 11). Two approaches can be identified in the use of the Web as a learning tool. First, modification of the Web to make it more suitable for learning. This is, for example, done in Web-based practices which offer selections of relevant, reliable and age-specific content that can be found on the Web (e.g., www.kennisnet.nl; www.docentenplein.nl). In addition, the by now familiar webquests are examples of attempts to use the Web for knowledge construction on specific subjects by offering students a selection of websites that can be used for

[2] The evaluation report of the project as well as practical guidelines for teachers with regard to incorporating the Web in inquiry activities can be accessed at www.onderzoekonline.net.

problem-based, real-life assignments (e.g., www.webkwesties.nl; www.digischool.nl). The overall aim of these practices is to modify Web-based resources (e.g., by preselecting websites or offering portals) in order to make them more useful and productive in education, and thus to create better opportunities for learning. In educational research, this approach has, for example, been elaborated by De Vries (2004) and by researchers of the University of Michigan (e.g., Hoffman, Wu, Krajcik & Soloway, 2003). A second, and in our view equally important, approach does not adapt (access to) the Web but concerns the Web itself and also addresses its users, i.e. investigates students' ways of using the Web, their Web skills and the support they need when using the Web at school. As illustrated in the quotations preceding this introduction, the use of the Web is common and widespread among children and teenagers. It is part of their everyday lives. At the same time, the Web is being used as the present-day alternative to library books. This suggests the need for an investigation of its potential use as a tool for knowledge construction.

This thesis is an exponent of the second approach, focusing on students in the upper grades of primary school and is guided by the following general research problem:

How can students be supported in using the Web for knowledge building?

We attend to this research problem in two ways. The first research question focuses on which kind of support is necessary and is formulated as follows:

a. **Which skills do students need when using the Web for knowledge building?**

The second research question focuses on two ways of supporting students in learning 'Web literacy skills' and is formulated as:

b. **How can Web literacy skills be learned within the context of an educational program and what are the learning results of such a program?**

4_ Thesis layout

Part I of this thesis reports on a comprehensive literature study (Chapter 1)[3]. A multidisciplinary approach was adopted, focusing on a broad range of literature, from educational research to research originating in the library and information science, reading research, and critical pedagogical literature. Together, these offered a theoretical elaboration of the characteristics of the Web, as well as insight into the

[3] Because the four main chapters consist of articles written for international journals, some repetition is inevitable.

characteristics of children's spontaneous Web behavior. This provided knowledge of the skills students need when using the Web for knowledge building (research question 1) and indications as to the various skills the concept 'Web literacy' should contain.

In part II of the thesis, we report on the empirical stage of our research, in which we investigated, by means of case studies, two alternative ways to teach students such Web literacy skills (research question 2). Both alternatives were designed as projects on the subject of 'healthy food', in which students acquired Web searching, reading and evaluating skills. Although both programs had the same learning goals and intended to incorporate learning Web literacy skills into the learning context of a specific knowledge domain, they differed in the ways they tried to accomplish those goals. The outlines and rationales of both programs are discussed in the introduction of part II. Since acquiring Web literacy skills is important for all students, one version was designed as a method that is relatively easy to apply and that guides both teacher and students through lessons on the various Web literacy skills. This first program may be characterized as 'sequential'. Chapter 2 reports on the evaluation and results of this program. However, with a view to the educational views on collaborative knowledge building and active and independent learning mentioned in section 2, we designed a second program that may be characterized as 'inquiry-based'. This version consisted of collaborative inquiry activities guided by students' own research questions, in which the teacher incorporates the teaching of Web literacy skills into these activities. We report on the evaluation and results of this program in chapter 3. Both chapters use a multiple case study design, given our primary wish to gain insight into the possibilities and limitations of both alternatives in terms of implementation and learning results.

In chapter 4 we return to our first research question, and readdress the skills students need when using the Web for knowledge building, on the basis of our empirical data rather than on the basis of a literature study. By means of an in-depth study of students' use of Web skills and strategies in post-program assignments, we seek to identify specific characteristics of Web strategies that explain when and why students use the Web adequately or inadequately. Thus, we attempt to provide additional insights into the further conceptualization and teaching of Web literacy.

Finally, in the Conclusion and Discussion section we return to our general research question and discuss the most relevant conclusions and consequences for educational practice and research.

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Part I

Chapter 1: The Web as an information resource in K–12 education:
Strategies for supporting students in searching and processing information 19

Chapter 1

The Web as an information resource in K–12 education: Strategies for supporting students in searching and processing information[4]

The use of the Web in K–12 education has increased substantially in recent years. The Web, however, does not support the learning processes of students as a matter of course. In this review, the authors analyse what research says about the demands that the use of the Web as an information resource in education makes on the support and supervision of students' learning processes. They discuss empirical research focusing on the limitations of the actual search strategies of children, as well as theoretical literature that analyzes specific characteristics of the Web and their implications for the organization of education. The authors conclude that students need support in searching on the Web as well as in developing 'information literacy'. Future research should focus on how the use of the Web in education can contribute to the development of deep and meaningful knowledge.

[4] Kuiper, E., Volman, M. & Terwel, J. (2005). The Web as an information resource in K-12 education: strategies for supporting students in searching and processing information. *Review of Educational Research, 75*(3), 285-328.

1_ Introduction

The Web is increasingly used as an information resource in K–12 education. More and more schools are connected to the Internet, and in many countries governments stimulate the use of the Internet in education. American statistics on Internet use in education show that 99% of public schools in 2001 had access to the Internet (National Center for Education Statistics [NCES], 2002). A multitude of 'good practices' can be found on the Web: initiatives by schools and educational-support institutes aimed at the optimal use of the Web as an information resource in education. A well-known example from the Unites States is the Big6 approach (Eisenberg & Berkowitz, 1992; www.big6.com). The American Library Association (www.ala.org) has also highlighted the importance of information literacy curricula in schools.

Three important reviews on the use of information and communication technology (ICT) in education have been published in recent years, two in the Review of Educational Research (Dillon & Gabbard, 1998; Fabos & Young, 1999) and one in the British Journal of Educational Technology (Song, 2002). Another review was published in the field of library and information science (Hsieh-Yee, 2001). These reviews pay only limited attention to the use of the Internet by children and the context in which the learning processes of students occur. Fabos and Young's review (1999) is an exception in these respects. It focuses primarily on the communicative use of ICT in educational situations (the use of e-mail projects) and not on its use as an information resource. The review by Dillon and Gabbard (1998) is restricted to quantitative, experimental, empirical studies on the learning outcomes of the use of hypermedia in higher education. Song (2002) discusses ten studies on the interaction between students' learning skills and various forms of hypermedia instruction. Hsieh-Yee's review (2001) of research on the Web-search behavior of children and adults pays no attention at all to educational context.

An educational approach to research on the use of the Web by children is, in our opinion, both relevant and necessary. The use of ICT in education in general, and the Web in particular, has consequences for the organization of education and the relationship between teacher and student. Kristmundsson (2000) rightly states that for the first time in the history of education it cannot be assumed that teachers are ahead of their students in a particular field. He refers particularly to technical computer skills, which many students have a better command of than their teachers. Teachers do maintain their advantage, he immediately adds, when helping students convert information into meaningful knowledge. Frechette (2002) refers to another aspect of the Web in stating that "the traditional role of the teacher as the 'fountain

of knowledge' must be reconsidered as massive amounts of information are readily accessible on the Internet .... With the continued emergence of new technologies, learning will be less about knowledge residing in the head and more about learning the pathways to knowledge" (Frechette, 2002, p. xvii). Snyder (1998) argues that the use of hypertext makes a different way of learning and teaching possible and stimulates active, self-directed, and exploratory learning, in particular. She also points out, however, that using potentially innovative technology does not necessarily lead to change: "No technology ... can guarantee any particular change in cultural practices simply by its 'nature'. A hypertext classroom can be used either to support new theories of reading and writing or to promote traditional approaches to the study of texts .... The use and effect of a technology is closely tied to the social context in which it appears" (p. 140).

Thus the use of the Web, like other ICT applications, does not provide support for the learning processes of students as a matter of course. The Web should rather be seen as a tool that in certain conditions can play a role in the learning processes of students. The wish to explore the conditions for this kind of use of the Web is the reason for this review. Technical aspects, although important for the efficient use of the Web, do not fall within the scope of this review.

Windschitl's work (1998, 2000) has been a very significant impetus in prompting research questions on the importance of the Web in education. Windschitl particularly emphasizes the importance of asking critical questions about the added value of the use of the Web in education. "Educators (and researchers) should distinguish between the effects of using technology and the effects of using information" and should also distinguish "between accessing information and having a learning experience" (Windschitl, 1998, p. 28). He also argues strongly for an emphasis on the students in education research. Relevant research questions thus include the following: How do students search for and find information on the Web? How do they evaluate the information that they find? What learning processes occur during searching, and how do students process the information into a product? The contexts in which the Web can be used as an 'inquiry tool' and how students learn in such contexts are of particular importance. Windschitl (2000) strongly recommends that research be directed not only at measuring results but also at meticulously describing learning processes and learning activities.

The Web offers access to large amounts of information and holds a great attraction for children. Because of these qualities, it has great potential as a supplement to the educational tools traditionally used in the classroom. However, the Web has not been designed with a view to use in educational settings. Children must learn how to make it a useful contribution to their learning processes.

Knowledge acquired through the Web must meet the requirements for all knowledge acquired at school: It must be accurate, and it must be deep, flexible, and meaningful. Problems with the validity, thoroughness, and meaning of knowledge acquired through the Web have been pointed out recently (e.g., the 'butterfly defect'; Salomon, 1998). In addition, several authors observe that the use of the Web requires the development of new literacies (e.g., Snyder, 2002).

Our central question in this review is:

What demands does the use of the Web as an information resource in education make on the support and supervision of students' learning processes?

We formulate the following research questions:

a. What are the characteristics of the Web-search behavior of children, and what problems do the children encounter?

b. Which characteristics of the Web should be taken into account when using it in education?

In answering these questions, we bring together various bodies of literature. First, we discuss empirical studies of the ways that children use the Web in searching for information: studies in library and information science and education research in which information seeking is embedded in a broader curriculum context. Subsequently, we turn to studies that address distinct characteristics of the Web and the consequences for Web use in education. These are mainly philosophical studies with a critical pedagogical approach. However, the above-mentioned education research also yields recommendations for the use of the Web in education. In our conclusions we try to answer our general question and formulate guidelines for the support of students working with the Web. We also formulate directions for future research on the use of the Web in education. In the Appendix we present key information about the empirical studies discussed in our review.

In this article we focus on Web activities in K–12 education, with an emphasis on the upper elementary and middle school grades. The existing research on this topic concerns mainly those grades. Research on children younger than 10 years is scarce. Although the use of the Web by students with special needs receives growing attention, we do not address this particular group of Web users explicitly because of a lack of research-based literature.

2_ Method

The emphasis in the literature search has been on the period from 1997 to the first quarter of 2003. Research in this field was scarce before 1997. We have

included older relevant information if the research involved students searching for information with the help of CD-ROMs and if the conclusions were relevant to our research question. We have focused on the literature regarding K–12 education, with an emphasis on upper elementary and middle school grades. Research on older students was included if it was significant to our research question. We have limited our search to the SSCI and ERIC databases and have included empirical studies in the library and information sciences only if they were indexed in the SSCI.

As mentioned before, we did not focus exclusively on empirical studies in our literature search. We also searched for theoretical and philosophical publications that attempted to clarify the place that the Web could possibly have in education and the ways in which students can be supported in using the Web. We conducted a search in SSCI and ERIC by using a combination of keywords (descriptors): 'Web (-based) (including synonyms)/hypertext (including synonyms)' and '(primary/secondary) education, instruction, learning, reading (-strategies), information (-seeking, -searching, skills, retrieval)'. Next, we used the descriptors 'information literacy' (and related terms)/'critical literacy' and 'education' as well as 'information literacy'/'critical literacy' and 'internet' (including related terms) to search for more philosophical literature. In addition to the computer search, we scanned the references in recent articles for relevant material ('snowball method'), which resulted in new articles and book titles. Titles with references to online publications were also added in this way. The search produced 66 relevant titles, all of which were included in the review. Of these 66 titles, 24 reported on empirical studies; the other articles were of a theoretical, philosophical, or practice-oriented character.

3_ Web-search behavior of children: How do children interact with the Web?

3.1 Profile of the research

Research on the ways that children deal with the Web as an information resource has been in progress since 1997. From the early 1990s, however, research was already being done on the search behavior of children when using information resources other than books. This includes studies on how children search with OPACs (On Line Public Access), the electronic library catalogue (e.g., Nahl & Harada, 1996) and with CD-ROMs (e.g., Large, Beheshti, & Breuleux, 1998). Studies since 1997 are not always focused exclusively on children's Web searches but include their searches of combinations of sources, for example the Web, books, and CD-ROMs (e.g., Hirsh, 1999).

Most of these studies have been done in the field of library and information science and generally focus on the interaction between children and the Web. A minority are from an educational perspective (Kafai & Bates, 1997; Jones, 2002; Wallace, Kupperman, Krajcik, & Soloway, 2000; Hoffman, Wu, Krajcik, & Soloway, 2003). A few studies focus not on the actual search behavior of children but rather on how the children themselves regard Web use and their own search skills (Watson, 1998; Agosto, 2001, 2002b; Lorenzen, 2001; Large, Beheshti, & Rahman, 2002a).

Some of the researchers studied Web use in a natural (nonexperimental) educational setting, with students formulating their own questions to search the Web or completing curriculum-related assignments (e.g., Fidel et al., 1999; Kafai & Bates, 1997; Wallace et al., 2000; Large & Beheshti, 2000; Large, Beheshti, & Rahman, 2002b). Other researchers gave students assignments specially constructed for their research and not directly linked to the curriculum (e.g., Bilal, 2000, 2001, 2002; Schacter, Chung, & Dorr, 1998). Some of the assignments were closed (involving a question about specific information), some were formulated more openly (involving a more general assignment or problem). Most of this research did not involve whole classrooms.

Virtually all of these studies were descriptive. The research methods were qualitative, and the research groups were small. Some evaluative research was conducted (in particular with task characteristics as an independent variable) but in small groups (e.g., Schacter et al., 1998; Bilal, 2000, 2001, 2002). The education studies were so-called design-based studies or design experiments, that is, studies of learning in context through the systematic design and study of instructional strategies and tools (Design-Based Research Collective, 2003). Many used a combination of data collection methods, such as interviews, questionnaires, video and audio recordings, logfiles, think-aloud protocols, diaries, and registration forms.

Further analysis of these studies reveals that they address four topics: the search strategies used by children and their effectiveness; the influence of student characteristics on these search strategies; the influence of task characteristics on the strategies; and the influence of interface characteristics (e.g., design of the websites and structure and working of search engines). We have taken these four topics as the starting point for organizing our discussion of the literature.

3.2 Characteristics of search strategies and results

Searching for information on the Web can be approached in various ways. One can use keywords with various levels of complexity (e.g., searching with one keyword or several, using Boolean operators). Browsing is another possibility, i.e., going through an index by clicking on topics (e.g., the many sorts of startpages). Entering a specific Web address (URL) is of course another possibility. Finally, one

can use the links on a website. These refer either to information in the website where they appear (internal links) or to other websites (external links).

These strategies are reflected in the various conditions under which students engage in Web searching: They may be asked to use a search engine, to begin at a Web page that was created by their teacher, or to access a particular resource page. How effective a particular strategy is depends on several factors, such as the prior knowledge of the user, his or her skill in using the various strategies, his or her knowledge of the structure of the Web, and the sort of information being sought. Using keywords, for example, is particularly effective in a search for a specific kind of information that can be expressed clearly and effectively in keywords. Browsing, on the other hand, is especially useful in a search for general information about a broad subject. To use URLs effectively, one needs to have a specific address or know how URLs are constructed. Following links is useful if a user is aware of the structure of hypertext and the function of links. A danger of continually following links is that the user may become completely lost.

An increasing interest in children as the target group of Web use research has become apparent in recent years. Both the education and library worlds see children using the Web as an information resource for school assignments. This prompts questions how they search and how effective their strategies are. What do children do when they search for information on the Web, and what are the results of their searching? Children are observed and questioned, and their search actions on the computer are recorded in logfiles. Most studies involve both the search process and its results. A few look only at the search behavior or the search process itself, without paying attention to the results of the search (e.g., Agosto, 2002a, 2002b; Hirsh, 1999). A separate issue is the attitude of children toward using the Web and how they assess the relevance and reliability of the information that they find. When children search for information on the Web, they are often confronted with information that has not been written specifically for them, and with information that cannot automatically be assumed to be reliable and "true."

How do schoolchildren search the Web, and what are the results?

Kafai and Bates (1997) were two of the first researchers to look at the use of the Web by schoolchildren aged 6 to 12 years. In a study of children in Grades 1–6 in four schools, searching for information on the Web was incorporated into a classroom project. Special attention was paid to evaluating the relevance and reliability of the information. The research included entire classes, which varied with respect to the numbers of children and the exact themes. The researchers observed both the teachers and the children during classroom activities, and the products of the children's work (e.g., notes about specific websites) were included in the study.

All of the children received instructions that were suitable for their age and experience. Most of the children appeared to benefit from the instruction and supervision and ultimately were able to find relevant information themselves for their projects. The oldest children were also eventually able to work with search engines and keywords, but it was difficult for them to select good sites. Students did not have enough patience to read the descriptions of sites or to go through a whole list of results; instead, they tended to choose sites purely by title.

Schacter et al. (1998) concluded on the basis of an experimental study of 32 students (fifth and sixth grade) that children preferred to browse rather than use keywords. They searched fairly intuitively and did not work systematically. The students were given two tasks, one 'well defined' and one 'ill defined'. They were far more successful with the ill-defined task than the well-defined one. The authors concluded that searching for precise, concrete information makes high demands on the search strategies of the Web user. In contrast, vague abstract tasks are far more suitable for browsing, which children enjoy and do with ease. An ill-defined task also implies that there are more potential answers, which increases the chance of finding an answer. We will discuss this further in section 3.4 on the influence of task characteristics.

Lyons, Hoffman, Krajcik, and Soloway (1997) placed the use of the Web in the context of inquiry activities in the science domain. They observed four students (two in the sixth grade and two in the ninth grade) using the Web to search for answers to their own questions in the same specific scientific domain. They concluded that the students still needed a great deal of help in searching online for information. With regard to the actual search, students clearly had particular difficulty in searching with keywords. The choice of keywords, incorrect spellings, and the use of Boolean operators caused many problems. Nevertheless, with sufficient help students were ultimately able to find suitable information. This University of Michigan research group has been involved in this field of research for a number of years (e.g., Wallace et al., 2000; Hoffman et al., 2003). Their previous work made it possible to develop an ongoing line of research in which the instructional context of Web use was amended on the basis of previous research results. After following eight sixth-grade students working on their own queries on an ecological theme, Wallace et al. (2000) concluded that although the students had sufficient technical skills, they were unable to use the information that they found on the Web to answer their queries. This was due primarily to the way in which they approached searching – they searched for specific answers and specific websites where the answers could be found. The students were involved almost exclusively in searching and collecting information and did not consider how they then could use the information to answer

their question. They tried to find a concrete answer instead of collecting information from which they themselves could deduce an answer. During their search they did not surf at random; they searched in a restricted area. They scarcely took time to read the information, making an immediate decision on whether it was usable. They did use keywords, but rather randomly and unsystematically. These results prompted Hoffman et al. (2003) to choose another approach to the use of the Web for answering inquiries. Students now use a specially designed interface that structures and guides both their inquiries and their use of the Web. Teachers also have received more training on supervising students. This leads to better searching in terms of the 'accuracy of content understandings', 'depth of content understandings', 'strategies', and 'qualities of resources' (Hoffman et al., 2003).

Fidel et al. (1999) observed eight 11th- and 12th-grade students searching for information on the Web for a homework assignment. Despite the age difference in comparison with the students in the studies mentioned above, this group also searched for information unsystematically. "The interactive nature of the Web supported the students' belief that there was no need to plan ahead because the progression of a search would be largely determined by what they saw on the screen" (p. 27). The students often began searching by entering a Web address or a keyword that they had used before. Their search behavior was remarkably similar to that of the students in the study by Wallace et al. (2000). These students also searched in a 'highly focused' way, looking for actual sentences on the screen that contained the answer to their task. They hardly explored at all and continually 'circled around' a few familiar sites. Contrary to expectation, they did not allow themselves to be distracted by pictures or animations. Also like the children studied by Wallace et al. (2000), these students simply changed their question or topic if they could not find exactly the right information. In Fidel et al.'s (1999) study, students had to answer a number of questions in a biology lesson about a plant of their choice. Students were so focused on completing the assignment that they repeatedly chose another plant if they could not find all the answers about the plant they had chosen first. As in Wallace et al.'s (2000) study, most students decided quickly whether certain information was relevant, not looking at the whole text but often only at the beginning.

Jones (2002) also encountered students who interpreted searching for information in response to an inquiry as looking for the 'correct answer'. In an experimental study, Jones analysed the results of 100 students (in 9th and 10th grade) searching the Web under two different conditions: a 'less structured condition', in which students were free to search the Web as they wished and were given little online support, and a 'structured condition', in which students had access to only

selected websites, which were relevant to the subject, and received extensive online support. All the students were given the same research question, on which they had to collect information and write a paper. Data were collected via student interviews, the timetables kept by the students, teacher interviews, observations, student questionnaires, and the assessment of the students' papers. The research task assigned to students was part of a class project on ecology. Students who were not allowed to search freely on the Web said that they missed the freedom. Contrary to expectation, the students who were allowed to search freely made little use of the opportunity. Jones associates that result with the fact that the students were searching first and foremost for the 'right answer'. They simply expected that the sites selected by the teacher would provide the answer and were afraid that they would use incorrect information in their paper if they searched for themselves. Jones concluded that students need access to preselected websites as well as the opportunity to search freely on the Web. In both cases, online support and support from the teacher are absolutely essential.

Hirsh (1999) monitored 10 fifth-grade students who were searching for information to write a paper on a sportsman or sportswoman of their choice. Given the nature of the assignment, the students did not find searching with keywords difficult. Again, the students looked mainly for specific information, quickly judging whether a text would be useful by reading only the first few lines. The students adhered closely to the conditions laid down by the teacher for the assignment, which explains in part why they did not explore the Web much. Students' search behaviors also reflected larger classroom expectations for giving the 'right answers'. Hirsh did not connect this tendency with the wider educational context. Wallace et al. (2000) found the same tendency, and they concluded that inquiries on the Web must be incorporated into a broader educational approach: "In many classrooms and schools, students are accustomed to seeking correct answers and producing work that meets clear specifications, laid out in advance. Getting on the Web to 'do inquiry' is unlikely to cause a change in that orientation even in the short term" (p. 100). Large and Beheshti (2000) conducted research on a group of 50 sixth-grade students, observing the students and interviewing them about their experiences using the Web as an information resource for a school assignment. The students had a great deal of trouble selecting the right keywords and much preferred to browse rather than search with keywords.

Bilal (2000, 2001, 2002) did research on the use of the American children's search engine Yahooligans! by 17 students aged 12 and 13 (in seventh grade). She gave the students three tasks in an experimental setting (see also section 3.4). Bilal (2000) designed an analysis method, the 'Web Traversal Measure', to determine the

effectiveness and efficiency of the children's search strategies. The measure was based on the scores achieved by students for the relevance of each search move and hyperlink activation. Students were also interviewed, in particular to include the affective side of searching the Web in the study. In all three tasks, students spent more time browsing than searching with specific terms. Jumping quickly and frequently between sites, clicking on numerous links, a lack of orientation, great difficulty with more abstract information, and large quantities of textual information were typical of their search processes. Her results on the research task (Bilal, 2001) agreed with those of Fidel et al. (1999) and Wallace et al. (2000) – students tried mainly to find a concrete answer instead of collecting information from which they could deduce an answer themselves.

How do children assess the information they find on the Web?

It is important that children be able to assess the relevance and reliability of Web information. In fact, they must continually ask themselves, "Can I use this to answer my question, and do I think that what it says is true?" Attitudinal aspects play a role in the children's processes of evaluation. Information presented in a way that is attractive to children is more likely to capture their attention and also possibly to be assessed more positively. Evaluation is, of course, also an important issue with other printed information, but the Web makes higher demands. Children have easy access to information, large quantities of information are often involved, and the authority and reliability of the information cannot be assumed.

On the basis of a study involving a group of 15-year-old girls, Agosto (2002b) constructed a theoretical model of the criteria that young people use to evaluate websites. Appreciation of graphical elements (color, font sizes and styles, and animations) plays an important role, albeit a strongly personal one. The appearance of a website is important, but appreciation of it varies from person to person. Similarly personal are preferences regarding the 'tone' of a site. Students also evaluate sites on their content – the expected relevancy and reliability – but often use inappropriate criteria to determine those characteristics (e.g., equating quantity with quality). Interactivity is an important criterion, with the availability of numerous links playing less of a role than the possibility of playing games, educational or otherwise. The objective of looking for information is important, as students clearly differentiate between the criteria for websites for a school assignment and those for sites to visit in their free time. On the basis of another study, Agosto (2002a) pointed out the importance of constraints in evaluating Web information. Students stopped searching not only when they thought they had found enough information of the right quality but also in response to time pressure, tiredness, and boredom. They were bored by websites with large amounts of text and few visual elements and

quickly clicked them off. We have already mentioned many studies that highlight the limited nature of the search behavior of children (e.g., Wallace et al., 2000; Fidel et al., 1999; Bilal, 2002). Agosto (2002b) points out the function of such behavior. Children search for ways of dealing with the confusingly large amount of information that they encounter on the Web. One can ask how effective such 'coping behavior' is. The research of the Michigan group shows that it does not necessarily lead to the development of knowledge and understanding.

Hirsh (1999) researched the criteria that a group of fifth-grade students used in evaluating information on the Web for a school assignment. The students' most important criterion was how relevant the content was to their subject. Their interest in the subject was also shown to be important. They scarcely assessed the reliability and authority of the information at all. Lorenzen (2001) asked 19 students in 10th and 12th grades about their assessment of information on the Web. He concluded that most students either did not evaluate the reliability and correctness of the information or used incorrect criteria in their assessment. Students assumed, for example, that the results of a search engine are qualitatively good, and they equated quantity with quality (i.e., a website with a lot of text is good). Other studies also show that many students do not question the reliability and 'correctness' of the information and assume that it is correct (e.g., Schacter et al., 1998; Kafai & Bates, 1997; Watson, 1998; Large & Beheshti, 2000).

Students were explicitly asked in a number of studies about their appreciation of the Web as a source of information. These studies showed that most students like using the Web despite the problems they encounter. Fidel et al. (1999) concluded that students particularly value the multimedia character of the Web, as well as the amount of information that can be found, the ease of access to the information, and its topicality. This explains in part why searching for information is evaluated negatively when the information cannot be found quickly. Large and Beheshti (2000) also found in their research (see above) that students appreciate the ease of searching on the Web; it is much faster and requires less effort than searching in books. Nevertheless, many students are disappointed with the results of their searches. Their expectations and actual search results do not coincide. Watson (1998) questioned 9 eighth-grade students in detail about their perceptions of using the Web. These students were positive and full of self-confidence. They liked using the Web, felt extremely sure of their skills, and considered the Web to be a valuable information resource. Watson (1998) added that this self-confidence is related predominantly to a technological approach, that is, the use of the Web as a 'tool', as an instrument for gathering information. The students in this study, like those in the

other studies, did not examine content or assess its quality – that is, its relevance, reliability, and authority.

Ng and Gunstone (2002) concluded on the basis of interviews with 22 students about 15 years old (10th grade) that using the Web is very motivating. These students felt that the Web gave them control over their learning process, making them less dependent on the teacher and their classmates. Like Watson (1998), Ng and Gunstone warned of the dangers of students' sometimes too-technological approach to searching for information on the Web. The authors pointed out that, as a result, weaker students in particular may appear to be learning with the help of the Web when in fact all they are doing is gathering information without processing it into understanding and insight. This study showed that it was difficult for these weaker students to find really good information. They needed supervision and help with structuring their work properly.

3.3 Student characteristics

If we consider searching for information to be an interactive process between user and the Web (Wang, Hawk, & Tenopir, 2000), the characteristics of the user are an important factor that influence both the search process and the search results. Student characteristics are not an object of research in most of the studies on children's Web use, but the research results of these studies do throw light on the role that student characteristics do and can play. Students with special needs are a particular user group who until now have received insufficient attention in the research.

Students' prior knowledge

The level of prior knowledge of the task and domain is considered to be a factor influencing the ultimate research result (e.g., Fidel et al., 1999; Hirsh, 1999). Prior knowledge of a specific subject makes it easier both to formulate suitable keywords and to evaluate the relevance and reliability of the information. The level of Web skills can also be expected to influence the search process (Fidel et al., 1999). It must be pointed out, however, that the level of technical skills says nothing about a student's ability to process the information into meaningful knowledge. Fidel et al. (1999) formulated how prior knowledge and search skills can influence each other, noting that "being somewhat knowledgeable of the topic being searched is necessary for learning how to search the Web, and that being somewhat knowledgeable about Web searching is necessary for exploring new topics" (p. 34).

Students' attitude

A positive attitude toward the Web and successful experiences in searching the Web are also mentioned as important student characteristics. The fact that most

children like using the Web does appear to influence their involvement and activities, although this says nothing about the results of their searching (c.f. Wallace et al., 2000). Kuhlthau (e.g., 1997) repeatedly refers in her publications to the importance of including the affective characteristics of students during the process of searching for information. Students experience all kinds of emotions associated with the information search process that have an important function in that process, such as optimism at the beginning, a feeling of frustration when they cannot find information, and satisfaction when they succeed.

Mistler-Jackson and Songer (2000) carried out a case study on the influence of a particular technology-rich program on students' motivation levels with regard to learning science and the use of technology. Sixth-grade students participated in the Kids as Global Scientists (KGS) project, an inquiry-based program using Internet software to study weather topics. The findings of this case study suggest that programs like KGS provide valuable motivational and learning opportunities for students. The authors stated that attitudes such as student engagement and motivation may affect the quality and nature of understandings that students develop.

Students' gender

Large et al. (2002b) were the first (and until now, the only) researchers to explicitly focus on the role of gender differences in Web use. They carried out an empirical study on a group of 53 sixth-grade students (30 girls, 23 boys) who searched in single-sex groups for information on the Web for a school assignment. The researchers wanted to know whether the boys' groups behaved differently from the girls' groups, and if so, what were the differences and similarities. The results showed that boys appeared to use different search strategies than girls did, and with different results. Boys used a single keyword more often when searching for information; girls used combinations of keywords more often. Boys' search strategies resulted in many more pages per search than those of girls. They also seemed to be more active in general in their use of the Web, clicking more often on links than girls and also jumping backward and forward between pages and navigating more. Boys' groups also spent significantly less time on looking at each Web page than girls. Large et al. did not question the students about their search strategies, so the study does not give any explanation for the causes of these differences. The authors suggested possible explanations, however. The girls' groups may have paid more attention to negotiation and cooperation, both of which take time and make navigating the Web slower. The fact that boys spent less time reading the texts may be associated with more difficulty in reading them and less interest in doing so. Large et al. assume on this basis that "the academic and behavioral differences between boys and girls offline also appear online in the Web environment" (p. 442).

Agosto (2001) took gender as the starting point for a different sort of research. Based on literature research and interviews with 33 girls aged 14 and 15, she designed a 'Gender Based Website Evaluation Model'. This model has eight evaluation criteria: 'social connectivity', 'flexibility and motility', 'contextuality', 'personal identification', 'graphic and multimedia concentration', 'collaboration', 'inclusion', and 'confidence'. Agosto argues strongly for applying these criteria in educational situations in which useful websites are preselected.

Schacter et al. (1998) used gender as a control variable in their research (see also section 3.2). Girls and boys were evenly distributed between the different conditions. The research results showed a gender difference on one point. Boys browsed significantly more than girls. The researchers did not have sufficient data to elaborate on that observation but suggested that boys probably either went through most of the information quickly or did not read it at all.

Of the remaining studies, only those by Hirsh (1999) and Large et al. (2002a) paid brief attention to gender differences. In her study on evaluation criteria in searching for information on the Web, Hirsh (1999) commented that boys immediately started searching, whereas girls took their time. Large et al. (2002a) concluded in their research on children's opinions on four search engines for children that girls and boys had different preferences for a specific search engine. The authors did not go into detail, however.

For many researchers, gender differences evidently are not an issue, despite the evidence of differences between boys and girls in computer use, attitudes toward computers, and ICT skills (Volman & Van Eck, 2001). The current lack of research in this area may be due in part to the short tradition of research on Web use by children.

Students' age

Researchers generally limit their studies to students in a specific age group. Only Kafai and Bates (1997) included several grades in their research. They concluded that as children get older they are more able to formulate **why** a particular website is useful or not. Younger children are able only to indicate **that** they like it or find it useful. Other differences between grades (e.g., search skills) are directly linked to the amount of practice and instruction that children have had and the cognitive abilities of children of a particular age.

A few researchers have included the characteristics of the age group in question in an explanation of the research results. Hirsh (1999), for example, makes a connection between the concrete operational phase of development (in Piaget's terms) and the fact that the children in her study (who were 10 to 11 years old) searched mainly for information in which exactly the same terms were used as in

their assignment: "[T]hey are concrete thinkers and have trouble with anything that is not an exact fit with their understanding of the question" (p. 1279).

3.4 Task characteristics

The literature devotes relatively extensive attention to the influence of the task characteristics on the process of searching for information by children. Tasks (or assignments) can differ on a number of points. First, there is a differentiation between 'imposed queries' (in which a student searches for information for an assignment set by the teacher) and 'self-generated queries' (in which students search for information of their choice, posing their own query) (Gross, 1999). It can be assumed that such a differentiation will have an influence on students' motivation. It is also linked to the differentiation between searching for information in the school context and in an out-of-school context. Agosto (2002b) refers to this when she comments: "To the girls in this study, two major categories, or schemata, framed their lives: the school schema and the nonschool schema. Web queries, and nearly everything else in their lives, fell into one of these two categories" (p. 336). How students in this study appreciated a website was linked to the purpose of the information. A 'boring' website with few illustrations and lots of text was considered to be negative if the information was for personal use but was considered to be positive if it was for use at school. This also points to different search behavior.

A differentiation can also be made by the structure of a task: Ill-defined tasks (or 'searching tasks') are assignments for which the answers cannot be precisely formulated in advance and the necessary information cannot be predetermined. Well-defined tasks (or 'finding tasks') are assignments for which only one answer is possible, an answer that is predetermined. In addition, a differentiation can be made by context. An assignment can either be part of a broader context, possibly a curriculum context, or stand alone.

Task characteristics always play a role in studies on the Web-search behavior of children, but they have been the central focus of research in only one or two studies. Most studies do not explicitly include task characteristics in the discussion of the results. However, the precise assignment set by teachers and researchers may influence students' search strategies as well as the assessment of the information that they find on the Web. Agosto's (2002b) study and the research by the Michigan group (Wallace et al., 2000; Hoffman et al., 2003) show in different ways the importance of the context of students' Web searching: Both the students' searching for 'specific answers' and their preference for specific websites are influenced by the instructional context of the task.

Bilal (2000, 2001, 2002) has taken task characteristics as the starting point for three studies on the Web-search activities of children (see also section 3.2). The

same group of students were given a 'fact-based search task' (searching for an answer to a factual question), a 'research task' (searching for information to answer an inquiry), and a 'fully self-generated task' (searching for information on an inquiry they had thought of themselves). For the last two tasks the students were asked to mark relevant texts on a printout; for the first they were expected to find the correct answers. In fact, two sorts of task characteristic were involved here. Differentiations are made, on the one hand, between 'imposed' and 'self-generated' tasks and, on the other hand, between an information query (well-defined) and a research query (ill-defined). The students had the most trouble with the research task and were most successful with the question of their choice. Bilal (2001, 2002) explains this result in part by the fact that the students' own research tasks tended to be simpler than the other tasks and that the students could change the question if they could not find enough information. Their own questions concerned topics that the students already knew something about; prior knowledge makes searching for information easier. Moreover, students' own questions differed greatly and were hence difficult to compare. Bilal also made a connection with motivation: The students preferred searching for information on their own question, which had a positive effect on their search behavior. A comparison of fact-based and research tasks showed that students had less trouble with the former. Bilal (2001) linked this result to students' lack of inquiry skills and lack of interest. The latter was due to the fact that the students did not find the question interesting and the teacher did not assess the assignments. We found it interesting that, in Bilal's research (2001, 2002), lack of interest on the part of students had more influence on research tasks than on fact-based tasks. Motivation possibly played a greater role when the task was more complicated for a student.

Schacter et al. (1998) differentiated between well-defined and ill-defined tasks in their study. They assumed that children would have more trouble with a finding task than with a searching task because of the structure of the Web, which made it extremely difficult for children to find specific information (the well-defined task), and relatively easy to collect information for an ill-defined task. The study confirmed their hypothesis but contradicted Bilal's findings (2000, 2001). It should be pointed out, however, that the assignment in Schacter et al.'s study appeared to be a much more difficult question than that of Bilal (2000), and in any case pertained to a different field.[5] The literature pays insufficient attention to the degree of difficulty as

[5] The question in Bilal's study (2000) of seventh-grade students was, "How long do alligators live in the wild, and how long in captivity?" Schacter et al.'s question (1998) for fifth- and sixth-grade students was, "What are the three types of crime that happen most in California?"

a task characteristic; in studies that are not part of the curriculum, researchers rarely mention whether the task has been tested in this aspect.[6]

The assignments in the studies of both Bilal (2000, 2001, 2002) and Schacter et al. (1998) were not part of an educational context. An observation by Hirsh (1999) on the influence of task characteristics on research results is significant in this connection: "Students, searching for information needed for a real assignment, may have a different set of goals and a higher motivation level than students performing an artificial search for an external researcher" (p. 1278). We would like to point out here that in a 'research' or ill-defined task, the question of what exactly is expected of students is also relevant. In Bilal's study (2001) the children had to collect information, print out that information, and then indicate on the printout what they thought was relevant to their question. The research assignments in the studies of Wallace et al. (2000) and Hoffman et al. (2003) were incorporated in a broader context of research activities. Students had to process the information that they had found in a paper or wall newspaper. The students in the study by Wallace et al. (2000), in particular, found the assignment extremely difficult. These researchers paid attention to many more aspects of the search process than was the case in Bilal's study (2001). This is partly due to the fact that the Web-search activities in study by Wallace et al. were not an objective in themselves but were an integral part of the teaching and learning process. Bilal (2002) herself also observed, "children's success should not be judged solely on finding the desired information. The process children adopt in seeking information, the 'meaning' or 'sense making' they derive from the information they find, the way they use the information are important factors in evaluating the information-seeking process" (p. 1181).

3.5 Interface/System characteristics

A user of the Web encounters technical characteristics that can influence the process of searching for information. Search engines make specific demands of the user because of their internal structure. They either have a directory structure (e.g., the familiar startpages) or use keywords (e.g., Google). In the former, the user browses through a number of categories and, having chosen a category, through several websites. In the latter, the user searches with a keyword (or a particular combination of keywords) based on his or her query. Search engines with the same structure can make different demands of the user on the formulation of keywords. Natural language querying is seldom possible. There are also huge differences in the

[6] This inattention to the difficulty of the task is particularly striking in the study by Schacter et al. (1998), in which the authors asked external experts to assess whether the question was ill-defined or well-defined.

structure and design of websites, for example, in the extent to which internal and external links are used and the availability of help for the user.

Studies in the field of library and information science, in particular, pay a considerable amount of attention to such structural characteristics, focusing on the question of how websites and search engines can be made more suitable for children. From an educational perspective, the consequences of the system characteristics for the way in which children learn to use the Web are more interesting. An example: The fact that most search engines do not accept natural language means that students need to be taught how to translate a query into keyword(s) and how to combine keywords. An additional choice in education is whether children should use search engines specially designed for children or general search engines.[7] The former are simpler but more limited, and children, for the most part, do not use them out of school.

Another issue is the preselection of websites on a specific subject to make it less confusing for children to search and to improve their chance of success. The factors that children themselves take into account when evaluating a website and what they do and do not consider worthwhile are important here. Studies by Agosto (2002a, 2002b) showed that children quickly 'click off' websites with a lot of text and few illustrations. Large et al. (2002a) also concluded that illustrations are important on the basis of focus groups held with students aged 10 to 12 years about children's search engines. The language used must also be suitable for the target group, and the size of the letters should not be too small. Colour is important, but a matter of personal taste. The interviews that Watson (1998) held with eighth-grade students indicated that time also plays an important role with children; downloading files or animations must not take too long.

3.6 Summary: Web-search behavior of children

We have approached the question of how children deal with the Web when searching for information from four perspectives. Research on **searching strategies and search results** shows that children often have difficulties in locating relevant information on the Web. They also have difficulties in assessing the relevance of the information. They hardly explore on the Web at all, and they stay focused on finding one answer to their question. Some studies look at the effect of **student characteristics** on the use of the Web. A number of gender differences have been found: Boys spend less time than girls reading the texts on Web pages, and boys use fewer

[7] An example of a Dutch search engine for children is Netwijs (www.netwijs.nl). Yahooligans! (www.yahooligans.com) and Ask Jeeves for Kids (www.ajkids.com) are English-language examples.

keywords in their searches than girls do. Some differences between older and younger students have also been found: Older students are more capable of abstract reasoning during the inquiry process. Task characteristics appear to be a relevant factor in many studies. Whether queries are self-generated or imposed and whether they are well-defined or ill-defined particularly make a difference for the inquiry processes and search results of students. The research results, however, are not unequivocal on these points. Studies on the effects of interface characteristics show a clear preference by children for websites with many illustrations and animations and a dislike of long segments of text.

Summarizing the results, we conclude that most researchers agree on two points. First, children must acquire search skills, as well as skills to use effectively the information that they find. Both types of skills require much training and support. Second, children rarely look at the reliability and authority of the information that they find; they either do not ask themselves about the authority of the Web or do not know how to evaluate the Web on this point. In the words of Hirsh (1999), "Children need better search skills to enable them to find the information they need and better information literacy skills to enable them to make informed decisions about the information they use" (p. 1281). There is clearly a role for education to fulfill here.

Figure 1 shows a summary of the major results of the empirical research regarding the Web-search behavior of children. The box on the right gives an overview of the research results on the characteristics of children's approaches to searching for and processing Web information. The boxes on the left list types of independent variables that have been connected with these approaches in the empirical research.

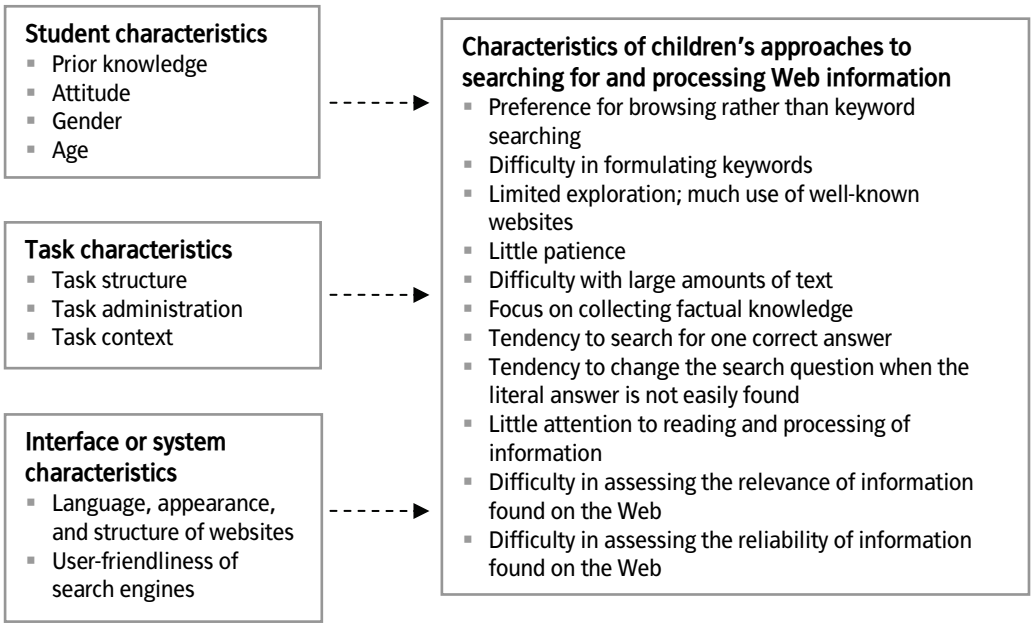

FIGURE 1: SUMMARY OF THE EMPIRICAL RESULTS REGARDING THE WEB-SEARCH BEHAVIOR OF CHILDREN.

4_ Relevant characteristics of the Web

4.1 Profile of the literature

Students evidently need much support and supervision when using the Web. The research results discussed in the literature provide ideas on this subject but no tested solutions (with two exceptions that we are aware of: Jones, 2002, and Hoffman et al., 2003). In this section of the review we discuss theoretical/ philosophical publications that deduce guidelines for the teaching–learning situation in which the Web is used as an information resource from the characteristics of the Web. The approach is not primarily descriptive (of what actually happens when children go on the Web) but is more philosophical: What can happen, and how should we deal with it? Most of these authors have a background in philosophy of education and a critical pedagogical approach. We also discuss empirical research whose authors seek ways to support students in the construction of deep and meaningful knowledge. These researchers also have to deal with the specific demands involved in the use of the Web in education.

4.2 Scope and topicality

The Web is already of enormous dimensions and is still growing at a rapid tempo. Moreover, it is an extremely up-to-date medium in comparison with written sources of information. It also contains very specialized as well as very general information. Furthermore, the information can be accessed exceptionally quickly in comparison with that from traditional sources. However, because so much information is available on the Web, it is no simple task for users to find what they need. Harada (2001) points out that "the sophistication, complexity and specificity of information obtained through electronic resources frequently exceed the comprehension levels of the students as well as their needs" (p. 3). Everyone has had the experience of entering a simple keyword and despairing at the number of sites thus produced, most of which are completely irrelevant. On the other hand, many children regard the sheer size of the Web as a plus (e.g., Watson, 1998; Large & Beheshti, 2000; Soloway & Wallace, 1997). They have the idea that they can find 'everything and anything' and that 'everything and anything' is always available to them, never out on loan as happens at the library. Here lies (not only for children) the seduction of the Web – the expectation that you can find an answer to every question and do so with a couple of clicks of the mouse (Todd, 1998). But in such an abundance of information it is not only difficult to find exactly what you are looking for but also of paramount importance to know precisely what you are looking for. It was apparent in the previous section that virtually all of the authors named were of the opinion, on the basis of their research, that students must have the skills not only to search for information but also to process and use it. The authors discussed in this section pay particular attention to the latter. Watson (2001) expresses the general concern as follows: "[T]here is a real danger that a fundamental purpose of schooling, to learn to know, is being swept aside by the need to acquire information. Where do the pupils learn the wisdom of how to use information, to challenge its assumption, its sources, indeed the very hegemony of 'Information'" (p. 256)? It is generally assumed that children easily acquire the more technical search skills, such as learning to navigate and use the search engines. The challenge for education lies in providing a context for the search for information. Loveless, DeVoogd, and Bohlin (2001) mention in this connection the problem that using the Web demands something of students that they were not accustomed to in traditional forms of education. To properly use the abundance of information, students must be capable of continually making decisions on their own information needs. Frechette (2002) also makes a connection between educational innovation and the use of ICT in the classroom. She stresses the importance of curriculum development in the field of the Internet, stressing in particular that inquiry activities

must from the basis of such a curriculum. She is not alone; many authors share the opinion that an 'inquiry-based curriculum' is the basis for making good use of the Web in a classroom situation. Many 'good practices' are attempts to develop such a curriculum.[8] It is generally thought that in this way students' search processes will acquire a context and the Web the place it deserves. Searching for information is not an end in itself but a means to answering broader queries or solving problems. In the previous section on Web search behavior of children we commented on students' inclination to use the Web mainly as a source of factual knowledge and for searching for concrete answers to their questions. That finding supports the argument for incorporating the use of the Web into a broader context. The research of Wallace et al. (2000), however, shows that this alone is not sufficient. Wallace et al. ascertained that in an inquiry-oriented curriculum students can nevertheless continue to search for concrete answers and focus strongly on completing their school assignment. The authors explained that result by pointing out that the students and teachers in question were not used to that kind of activity. The teachers' support was geared primarily toward completing the task and getting a mark quickly. Students, too, saw the Web as a means of finishing a task in a short time. This was obviated in a follow-up study (Hoffman et al., 2003) by more attention to supporting the process of pursuing inquiries. The authors concluded: "[I]t is clear that students can benefit from access to on-line resources when extensive support and scaffolding are provided by the teacher, but this is far from automatic. Expanded models for technology development, curriculum design, and pedagogical practices are required to instantiate on-line inquiry successfully through information seeking in content areas" (p. 343). The authors in the library and information science field, in particular, approached such an inquiry-oriented curriculum by applying all kinds of existing models for searching for information (e.g., Kuhlthau, 1997; Loertscher & Woolls, 2002; Pappas & Tepe, 1997). They also strongly recommended integrating such models into a curriculum context.

4.3 Accessibility

The Web is a 'democratic' medium from the point of view of both the authors (building a website is no longer reserved for a select group of specialists) and the users (in principle, everyone with a computer and an Internet connection has equal access to the information on the Web). Nevertheless, not everybody owns a

[8] Some examples of pragmatic sites that present recommendations for good practices are: *www.inquiry.uiuc.edu*; *www.fno.org*; *www.biopoint.com*; *webquest.sdsu.edu*; and *www.onderzoekonline.net*.

computer; there are also the 'haves' and 'have nots' regarding Internet use. Inequality is great – the well-known digital divide – even when we restrict ourselves to prosperous parts of the world such as the United States and Western Europe, where the percentage of people with access to the Internet is rising continuously. In the United States the inequality is reflected in the data on differences in how computers are used at school. Songer, Lee, and Kam (2002) quote research data showing that schools with many disadvantaged students (particularly in poor urban areas where children's access to the Internet at home is lower), computers in the classroom are mainly used for 'drill and practice', whereas schools in more prosperous areas use ICT for solving problems. Those schools also make far more use of the Web. Recent Dutch research confirms this finding (Volman, Van Eck, Heemskerk, & Kuiper, 2005). On the basis of such data it can be concluded that using the Web must be part of the curriculum, particularly in areas where children have less access to the Web at home, and schools should receive support for this (Mistler-Jackson & Songer, 2000).

Songer and her research group have also put this vision into practice. Songer et al. (2002) reported on the research on the project known as "Kids as Global Scientists: Weather" (a project in which students did research, formulating their own questions, on the weather in a technology-rich environment). The project has been implemented in a large number of schools, of which six in Detroit have been carefully monitored. The objective of the study was to identify the obstacles encountered in implementing such a project in schools in poor urban areas where teachers are not accustomed to working with students in this manner. The researchers observed and interviewed teachers and students and tested students on their domain knowledge at the beginning and end of the project. Although conditions in the schools were limited, the findings show that very positive results were achieved with the students. The students clearly had learned a lot, both about the specific domain (the weather) and about doing research. Moreover, the students expressed a great deal of enthusiasm and self-confidence and felt that the subject was relevant to them (unlike 'ordinary' science lessons). The teachers were also enthusiastic and learned a great deal from the project. Songer et al. (2002) considered the use of technology (in this case, wide-ranging use of the Internet) to be an essential factor in these results.

The fact that the Web is accessible to everyone who wants to place information on it – information that has not been assessed by others – can have both positive and negative aspects for children. The positive side is that children can easily become authors of information that is accessible to others. This means that children can make reports of their inquiry activities available on the Web. They are no longer

writing a report just for themselves, their teacher, and their classmates but for a far larger audience. This opportunity can, but does not necessarily, have a strong motivating effect on children (e.g., Kafai & Bates, 1997). Research by Bos and Krajcik (1998) on the attitudes of students who wrote laboratory reports for the Web shows that the students did not consider themselves to be any more motivated than when writing an 'ordinary' report. The negative side of the accessibility of the Web is that children can access information that is incorrect and possibly even harmful. How children can learn to deal with this negative side becomes a matter of concern for schools. A number of choices are involved: Is the main task of teachers to protect children –for example, by installing filters or other restrictions at the portal – or to teach children to approach information critically? Although most researchers consider the latter task to be very important, blocking access to certain parts of the Web is certainly not always dismissed as a solution (e.g., Farwick Owens, Hester, & Teale, 2002). Burbules and Callister (2000) group the negative aspects of the Web under the headings 'misinformation' (wrong or incomplete information), 'malinformation' (information that can be harmful, varying from child pornography to instructions for making bombs), 'messed-up information' (information that is so badly presented that it is unusable) and 'mostly useless information' (information that will be of interest to very few people, e.g., the many sites with webcams). They emphasize the paradox linked to the democratic quality of the Web: Although the Web offers an enormous diversity of perspectives, that diversity has the potential to scare off users, hence to exclude. Burbules and Callister express particular concern about young, inexperienced users who are scared off by certain subject matter because they lack the ability to interpret it and place it in context. The authors do not see censorship or filters, however, as the solution: "How can students learn to make good choices, social and intellectual, if choices are made for them by filtering out things they can and cannot see?" (p. 109). Moreover, filters are the result of making choices, choices that often have nothing to do with protecting students. Burbules and Callister argue strongly for far more emphasis on using the Web critically in school. Filters serve a useful function only for very young children. With older children, teachers should hold a continuing dialogue about their curiosity, interests, and feelings. This could include why certain texts or illustrations are good or bad. "This, then, is the educational challenge: helping students learn to operate in an environment that is inherently 'dangerous', to deal with what may be unexpected or unpleasant, to make critical judgments about what they find" (p. 118). Frechette (2002) argues in this connection for a critical pedagogy centered on the 'empowerment' of students. When students learn to deal critically with the from and content of the Web, they have more say in their own knowledge acquisition.

The accessibility of the Web can be looked at in another way. The Web is an information resource that, because of the nature of the access, is available wherever there is a computer. Looking up information no longer happens only in the library, it also (and more often) happens at home, school, or work. In practice, this means that students now have access to information in far more places than was the case with traditional sources of information. There is no longer a specific place where children work under the watchful eye of adults. Searching for information often takes place in the personal domain, without supervision from the teacher. Teachers must take into account that many students already have acquired knowledge and experience of the Web outside school. Valentine and Holloway (2002) show clearly from a geographical perspective how interwoven the 'virtual world' and the 'real world' are for children. Valentine and Holloway approach the subject mainly from the perspective of the deep concern of many adults – an unjustified concern, in the authors' view – about a generation of "computer kids" who neglect their social life in favor of the computer. In our opinion, it is important that education take into account the out-of-school activities of students on the Internet and the differences among students in this respect. Not much attention is paid to this subject in the literature. In a study on the use of computers by children at home, Facer, Sutherland, Furlong, and Furlong (2001) emphasized the importance of ICT use in education that explicitly takes into account the ways that students use computers in their daily lives. Children can already do a lot, have already learned a lot outside school, and will use those skills in an educational situation. Education often does not take this fact into account, as is confirmed in research by the Pew Internet & American Life Project (2002) on the opinions of middle school and high school students on how the Internet is used at school. Students experience the lack of acknowledgment of their skills as negative and disappointing and are hence less motivated to use the Internet at school.

4.4 Hypertext structure

The Web uses 'hypertext'. The contents both of the Web as a whole and of individual Web pages are structured not in a linear or hierarchical way but in a way that enables texts, opinions, and ideas to be linked to one another. "Hypertext is essentially a network of links between words, ideas and sources, one that has neither a centre nor an end" (Snyder, 1998, p. 127). This characteristic of the Web has consequences for 'reading' information on it. Users can choose their own path, far more so than in printed media, by following particular links or not. A link can lead to another text on the same site but also to other Web pages. The user is guided in part by the links created by the author of the website but is also able to create his or her own totality of information, separate from the author's intentions. Hypertext

offers the user many possibilities for obtaining information but also makes it easy to get lost. To keep this from happening, students must have a clear objective, namely an inquiry that can structure the search for information. Knowledge of the structure of the Web and the possibilities for navigating it also make searching easier. It is indeed difficult for children to understand that structure, but they, far more than the present generation of adults, are growing up in a society in which speed and haste are the norm in many areas of life (e.g., e-mailing, Instant Messaging (IM), using mobile phones, zapping from one TV channel to another, and playing computer games). Dresang (1997) and Jacobson (1995) emphasize that the structure and operating mode of the Web are particularly well suited to children. Children are used to speed and haste and like being able to make their own choices (Dresang, 1997); children are able to work intuitively with the Web, certainly more so than with traditional ways of looking for information (Jacobson, 1995). It is probably not a coincidence that these findings are not from the most recent literature. Now, researchers increasingly recognize the problems associated with children's Web use and know that an intuitive approach does not always have the desired result from an educational point of view. The ease with which children navigate the Web does not mean that children are better than adults at using it as an information resource. The hypertext structure gives users the impression that they can do anything. However, in the words of Laurillard (1998), "The paradox of interactive media is that being a user-control medium the learner expects to have control, and yet a learner does not know enough to be given full control" (p. 241).

The question of how students can learn to deal with Web texts is important for education. Does hypertext require a different way of reading than printed text? If so, what are the consequences for teaching reading comprehension, for example? Burbules and Callister (2000) emphasize the importance of a focal point for students. When students use the Web with a clear question, preferably their own, their searching and reading are more meaningful. In addition, teachers must realize that searching on the Web is not first and foremost about the passive acquisition of knowledge but about actively searching for the solution to a problem. Ultimately, it is a question of reading critically – reading and simultaneously evaluating the relevance and reliability of what you are reading. Burke (2002) also considers students' questions to be central in 'learning to read' Web texts. They must learn to ask themselves continually what it is they want to know, what is the purpose of knowing it, and what sort of information can contribute to that purpose. Such questions give direction to searching on the Web. Reading-comprehension strategies also play an important role, for example, in differentiating between facts and opinions, checking difficult words in a text, and so forth. Farwick Owens et al. (2002)

also emphasize the importance of continually 'questioning', for example, by learning repeatedly to ask the question whether what you are reading is connected to what you want to know. In this way students can avoid getting lost on the Web. The ability to 'scan' texts is also important.

Sutherland-Smith (2002) takes differences in reading strategies for printed text and Web text as her starting point. 'Reading' a Web text makes greater demands on critical reading skills than reading printed texts, because of the large proportion of nontextual elements, the possibilities for interactivity, and the demands that the nonlinear character of the Web make on the associative ability of the student. There are several useful strategies for teaching students how to deal with Web texts, for example, the 'snatch-and-grab' technique whereby a student quickly checks whether a text includes a certain keyword or sentence and then saves the text. This fits in with students' inclination to 'browse' the Web and keeps students from reading thoroughly every text that they find (which would not be sensible, given the frequently large amounts of information) and from just quickly scanning the texts without questioning their usefulness (Sutherland-Smith, 2002).

Coiro (2003) explains how the teaching of reading comprehension changes when Web texts are used as an information resource. She emphasizes the importance of learning to use links in a text by making students aware of what they are doing when they click on a link. She quotes Tapscott (1998), who describes this skill appropriately: "It's not just point and click. It's point, read, think, click" (p. 63). Links are, in this sense, constant decision points. Critically questioning the factual accuracy of Web texts and the motives of their authors is even more important than with printed texts. Coiro (2003) sees this as part of general 'critical literacy skills', whereby traditional research skills play an important role. She points out that the Web can be a huge hurdle for weaker readers and that this group should therefore receive extensive supervision and guidance. The sheer amount of information and the lack of a clear linear structure, particularly, can cause problems. Todd (1998) mentions in this connection that traditional indicators (such as the author's background and the references quoted) are often not provided on the Web. Moreover, information is often presented without a context that can give it meaning. Users have to deduce these aspects themselves from the information.

The Web offers the user more opportunities to work interactively than do printed media. These include navigating the Web, mentioned above, when the user follows his or her own path and there is interaction between the user and the Web text. Most websites also offer the user the opportunity to e-mail the maker of the website or the people mentioned on the site. It is also possible to participate in news groups on a particular theme through websites. This interactivity is often mentioned

as one of the unique educational possibilities that the Web can offer. Children have the opportunity to communicate with students from other schools and with adults. Such contact is much more difficult without the Internet. The ease of communication, however, may cause the navigator to sight of the objective of the communication. Fabos and Young (1999) conclude in their review of research on the results of e-mail projects that the educational value of such projects (in which students e-mail with students abroad) is mostly limited. Fabos and Young also question the value of the 'globalization' that becomes possible in this way, whereby students should become more aware of other cultures. The authors suggest that students would learn more by visiting a school in a nearby town or district than by e-mailing with children in another part of the world. Sorapure, Inglesby, and Yatchisin (1998) approach interactivity from a different point of view, noting that students must learn to question the function of the interactive possibilities of the Web. For example, why does the maker of a website give the user the opportunity to react?

4.5 Visual character

The information on the Web does not always take the from of text. Video clips, music clips, and audio recordings play a much larger role than merely illustrating text. They give the Web its own informative value, which is often far greater than that of illustrations in a book. 'Visual literacy' is a term often used in the literature as an aspect of general 'information literacy' (Frechette, 2002). This visual character of the Web strongly appeals to children (Frechette, 2002; Agosto, 2002b), who often judge a site mainly on the basis of the illustrations and other graphic characteristics. Children also make use of the possibility of easily adding illustrations to an assignment (e.g., Sutherland-Smith, 2002). The fact that 'scientific concepts' in particular can be made more understandable to students via the Web is important. Such technical possibilities of the Web appear to be used most in science lessons, possibly because the role of technology is dealt with more in these lessons than in other subjects. The line of research followed by Jones (2002), Wallace et al. (2000), and Hoffman et al. (2003) is firmly rooted in science as the subject taught; Krajcik (2002) emphasizes the possibilities offered by the Web of visualizing and analysing data.

The literature on learning how to deal with the Web as an information resource often includes the concept of 'visual literacy' but, in most cases, goes no farther than stating that children need to learn to assess the meaning and function of the visual elements of the information. The significant place of illustrative material on the Web is linked to communication media in general that are becoming increasingly visual in character. Pappas and Tepe (1997) mention 'comprehending and reading images' (p. 329) in this connection – learning to understand the function of images when

conveying a particular information objective. They consider this to be part of learning to handle communication media of all sorts and also include it in learning to handle information media critically. This means that images must be given as much attention as text and not viewed as merely supporting the text. Sorapure et al. (1998) discuss visual literacy in more detail. They mention, first and foremost, the temptation posed by image material on the Web; students can be easily distracted. Research does not conclusively confirm this. Fidel et al. (1999), for example, observed in their research that students did not let themselves be distracted from their task by illustrations and animations. Students concentrated primarily on finding text that would include an answer to their questions. The acquisition of visual literacy does not involve ignoring the visual elements but, rather, understanding them in relation to the text. Sorapure et al. (1998) interpret this kind of understanding in two ways. First, images must be considered to be an information medium themselves. Second, images are part of a website and contribute to the character of the site.

Moreover, 'reading' and understanding illustrations is a process in which knowledge and experience play a role. Education must take this into account, especially as the same illustration on the Web can be used in extremely different contexts. Students must learn that the meaning of the illustration can never be understood separately from the context. Sorapure et al. (1998) use the example of a painting ("The Scream," by Edward Munch) and show that this painting can be used on personal websites (as an example of something that the author really likes), on the site of a company selling posters and T-shirts, and on a medical site where Munch's art is related to a clinical illness. Moreover, an illustration may be used without the title, the name of the painter, or any indication of the original measurements; a painting in color may be represented in black and white. Students looking for information about the painting must be aware of these matters if they are to make a sound appraisal of the information that they find. This is a lot to ask of young children, but teachers can help foster the development of this kind of visual literacy. The ease with which illustrations can be found on the Web makes visual literacy even more necessary, as illustrations can be searched for independently of a textual context. The search engine Google (www.google.com), for example, has this kind of search option, which is popular with many students, who often use it to access textual information. Another element of visual literacy is developing an eye for the possibility that images have been manipulated. This possibility, indeed, is not restricted to the Web; however, the technical possibilities of the Web make manipulation extremely simple. It is also important to teach students to consciously look at the context of the visual material.

4.6 Summary: Web characteristics

Which characteristics of the Web must be taken into account when using it as an information resource in education?

The **size and topicality** of the Web imply access to vast amounts of information for students. But because the accessible information is vast, students must have good searching skills and must know exactly what they are looking for. In an inquiry-oriented curriculum, information seeking is not a goal in itself but is functional in finding the answer to a question. The **accessibility** of the Web implies that students have easy access to a great deal of information and can easily become 'authors' of information themselves. On the other hand, they can be confronted with erroneous, useless, and harmful information. Children need to learn that such a negative side of the Web exists and learn to cope with it. Censorship (e.g., through filtering) is a serious option only for very young children. The challenge for education is to teach children the competencies necessary for using the Web critically. The use of **hypertext** makes high demands on critical reading skills. Children must learn to ask themselves repeatedly why they are reading a Web text. Assessing the reliability of Web texts plays an important part here. Students also must learn to scan information quickly to ascertain whether it is useful and then read only the useful texts thoroughly. Finally, the **visual character** of the Web makes it necessary for students to learn to "read" the visual information and learn to judge it on functionality, meaning, and how it relates to the text.

All of the points mentioned above pertain to the ability to handle the Web critically, which can be defined as an aspect of information literacy skills.[9] Searching skills are part of information literacy, but the body of literature that we have discussed in this section emphasizes that information resources such as the Web must be used critically. That emphasis confirms the research results in the preceding section on the Web-search behavior of children. We conclude that children must possess both search skills and the skill to make purposeful use of the information that they find. They must be able to assess the accuracy and reliability of the information. Virtually no empirical research has focused on this ability. There have also been few attempts to study the support of students working with the Web.

[9] Here is a frequently cited definition of "information literacy" from the American Library Association: "To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information. Ultimately, information literate people are those who have learned how to learn" *(http://www.ala.org/Content/NavigationMenu/ACRL/Publications/White_Papers_and_Reports/Presidential_Committee_on_Information_Literacy.htm).*

Figure 2 summarizes the main points discussed in this section. The column on the right lists recommendations for supporting students when using the Web, based on either empirical or theoretical research. The column on the left shows the main characteristics of the Web that make these forms of support necessary.

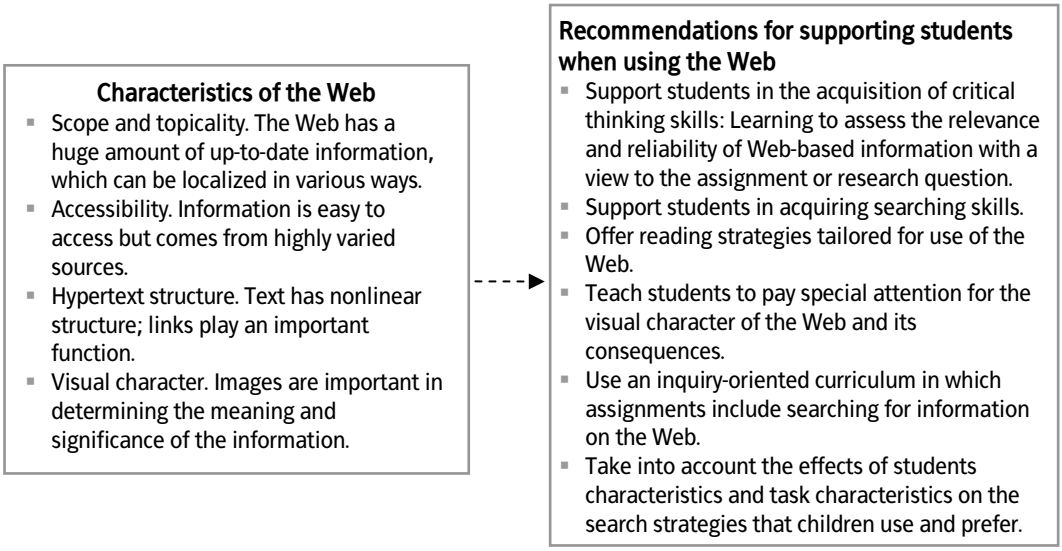

FIGURE 2: SUMMARY OF THE FINDINGS FROM THE LITERATURE REGARDING THE RELATION BETWEEN WEB CHARACTERISTICS AND RECOMMENDATIONS FOR SUPPORTING STUDENTS IN USING THE WEB.

5_ Conclusions

We have analysed the literature with a view to answering the general question, What demands does the use of the Web as an information resource in education make on the support and supervision of students' learning processes? Can we now actually answer this question? We can certainly conclude that use of the Web does make specific demands. There are essential differences between using the Web and using printed sources of information. This has consequences for the skills that students need in searching for and processing information. We can also indicate in general terms that students need supervision and support in acquiring both Web searching skills and 'information literacy' – the ability to critically assess the information that they find.

The research included in our review clearly shows that most students like using the Web but often do not possess the necessary skills to find the right information. And when they do find the right information, it is also difficult for them to use it to pursue an inquiry or solve a problem. Searching for information usually results in

insufficient knowledge, understanding, and insight. The literature therefore argues strongly for using the Web in the context of inquiry activities. In this way the Web serves a function in the curriculum, and children learn that finding information on the Web is not an objective in itself. Specific attention must be paid to learning to assess the relevance and reliability of information. This vision is shared by many authors who have a more philosophical or design-based approach to Web use in education. Based on analyses of the specific characteristics of the Web, they formulate points related to learning to use the Web critically. Many advocate providing plentiful time and space in the teaching and learning process to learning to read Web information critically and evaluate it, so that children can assess independently what information they need, the best way to find that information, its significance, and how to use it for the construction of knowledge. 'Information literacy' is an umbrella term that encompasses all of these aspects.

In this review we have brought together various bodies of literature regarding the use of the Web as an information resource in education. What can be said about the nature and quality of the studies reviewed?

What is particularly striking about the empirical research in the field of library and information science is that most studies are descriptive and small-scale. The results of the studies are often difficult to compare because they involve different age groups of students, different types of instructional context, different tasks, and different methods of data collection and analysis. To generalize on the basis of these studies is therefore not possible. Most studies focus on students' search processes – the collecting of information. The results clearly show what children do when they are searching for information, but the subsequent phase of processing the information is not addressed. Many of the authors themselves have pointed out this lacuna. Hirsh (1999), for example, says, "Additional research with children is needed... to follow children further in the research process to see how the information selected was ultimately used" (p. 1282). Bilal (2002) asks the question, "How does children's information seeking on the Web lead to meaningful learning?" (p. 1182). Schacter et al. (1998) conclude, "Research must move forward by analyzing not only what students find, but also how students use the information they find for a purpose" (p. 848). When comparing the studies with the Big6, a well-known and much-used model for information seeking (Eisenberg & Berkowitz, 1992), research is focused almost solely on the first phase, 'location and access'. Moreover, most studies isolate searching for factual information from the process of information seeking as a whole. Kuhlthau (1993) has developed a six-stage information search process (ISP) that has some unique characteristics, such as emphasis on the importance of feelings of (cognitive and affective) uncertainty in the process of information seeking and on the

stages of information seeking before the actual collection of information. Although the ISP originates in Kuhlthau's research in libraries, it is of great relevance for information seeking in general, including Web searching. Most empirical research on the use of the Web, however, focuses only on what Kuhlthau defines as Stage 5 of the ISP, the actual gathering of information. The first stages – which are focused on contemplation on the task, selection of a personal topic, and formulation of a perspective – are not taken into account.

The philosophical literature provides much insight into the possibilities and limitations of the use of the Web in education. Moreover, it provides a great deal of food for thought on how to teach students to use the Web in classroom practice. The authors often go no further, however, than general considerations that cannot be directly implemented in the classroom. Exceptions are those writing from a practical perspective themselves (e.g., Sutherland-Smith, 2002; Coiro, 2003); these authors combine their vision with recommendations derived from practical experience.

Design-based studies (e.g., Songer et al., 2002; Jones, 2002; Hoffman et al., 2003) are particularly valuable because they place Web searching in a context of inquiry activities. They pay much more attention to the beginning of the information search process (e.g., formulating a research question) and the processing of information (e.g., evaluating information, evaluating the search process, and assimilating the information). These empirical studies have a clear vision on education and make a link between the vision (What do we aspire to?) and the practical situation (What is actually happening, and how can this possibly be changed?). In our view it is important that future research continue this approach.

Windschitl (2000) has proposed three interesting criteria as guidelines for research questions on the use of the Web in an educational situation. He proposes that research questions should preferably be placed in an innovative educational context in which the dialogue between teacher and student, cooperation, and joint construction of knowledge are central. In addition, research must not only focus on measuring results but also on the learning processes that students undergo. Finally, the emphasis in research must be on those aspects of the Web that differentiate it from other forms of technology used in education: "[M]ore productive queries may be directed at examining entire Web-supported pedagogical approaches to teaching and learning.... Because the Web provides access to information, the focus should return to the students and how they use, share, and learn from this information" (p. 91).

The model in Figure 3 shows which aspects of the research field appear to be relevant for future research, on the basis of the results of this review. Two features of the model require some explanation. First, the attention to learning results: Most

studies reviewed in this article paid little attention to the results of children's search processes. In our view, it would be important to focus more on the results of search behavior by children in future research, as well as on the results of the various ways of supporting students in using the Web. Second, we want to stress the importance of paying systematic attention to the relationships among the components of the model. Most existing research lacks such attention.

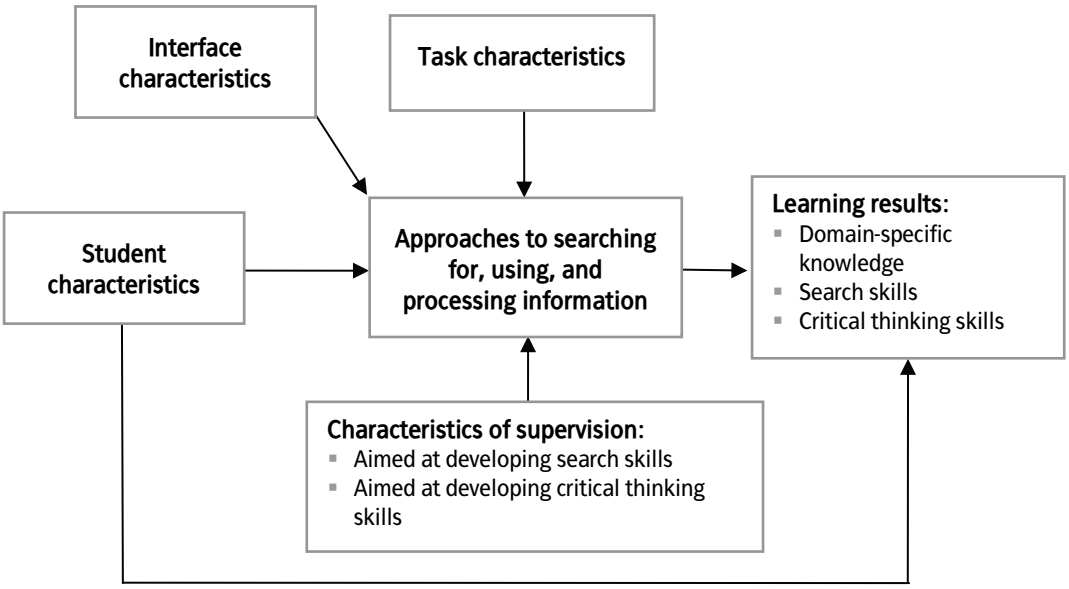

FIGURE 3: MODEL FOR FUTURE RESEARCH ON LEARNING PROCESSES AND LEARNING RESULTS IN THE USE OF THE WEB AS AN INFORMATION RESOURCE IN AN EDUCATIONAL CONTEXT.

In fact, all of these aspects require further attention in research. Here we argue most strongly, however, for research on strategies for supporting students, with the aim of developing search skills and critical thinking skills. We conclude with a number of recommendations:

- Future research must focus on the design of learning environments in which the use of the Web as an information resource is incorporated into a curricular context. Our preference is for an inquiry-oriented curriculum, in which searching for information is not an end in itself but a means to answering queries. The queries automatically provide, moreover, a structure for students' search processes. With this kind of curriculum it is also possible to involve the social environment and classroom organization in the research, as well as focusing the research more on didactic

recommendations for teachers. Given the limited research tradition in this field, we recommend a combination of qualitative and quantitative research methods.

- Research on students' search skills should no longer be restricted to the actual search behavior of children but should investigate ways for students to learn search skills in an educational situation. The research could compare the effects of various learning environments on the acquisition of search skills; for example, an environment in which students may search freely on the Web might be compared with an environment in which sites are preselected. Given that current research is often conducted with small groups of students, it would be sensible to make the research groups larger. Student characteristics and task characteristics must be explicitly included in the design of experimental conditions, thereby making it possible to generalize the research more and to look for differential effects for different categories of students. It is extremely important that not only the search process but also the results of that process be included in the research. Thus the research should indicate students' ability not only to collect information but also to transform the information into knowledge, understanding, and insight. Working with 'design experiments' (Cobb, Confrey, DiSessa, Lehrer, & Schauble, 2003) is a research methodology that can be particularly productive in this kind of research.
- Little research exists on the acquisition of 'information literacy skills'. The question is how the development of such complex skills can be fostered. Ideas from the philosophical literature must be translated into recommendations for the guidance of students, which then can be tested in research. For purposes of research it is advisable to divide an umbrella term such as 'information literacy' into operational terms for a number of subskills to facilitate the development of a specific learning environment that makes the process of acquiring those skills visible. At the same time, it must be remembered that information literacy is not simply the sum of its parts and cannot be reduced to subskills. Research in information literacy must, therefore, in comparison with research on search skills, pay more attention to following and describing learning processes. Thus insights can be gained into the conditions under which students acquire such complex skills. The 'design experiments' mentioned above are also a suitable research method here.
- Research that endeavours to determine under what conditions the use of the Web can contribute to the construction of knowledge must take into account the skills and preferences of students. Students want the aspects of the Web that they appreciate to be reflected in the ways that the Web is used at school (e.g., aspects such as the interactivity of the Web, the accessibility of information resources, and multimedia). The teaching and learning process must reflect the world as perceived by students, a world in which the Web is becoming matter-of-course. In our view this approach can

also help students to use the Web critically outside the educational context, as a source of information for private purposes.

- Research on Web use by children in education should preferably reflect an interdisciplinary perspective. Knowledge about the use of information resources in general (the domain of library and information science) can work together with knowledge about how information is used to develop understanding and insight (the domain of education research). A curriculum-theoretical perspective can also be useful here, particularly with regard to the design of learning environments. Together, various disciplinary perspectives can contribute to educational change.
- Finally, research on Web use by children in education should bear in mind the constant, rapid change that characterizes the Web and the educational practices that involve the Web. "The... paradox is that technology often changes faster than we can effectively evaluate its utility for literacy and learning." (Leu, 2000, online version, p. 23). This is a perhaps disappointing, but also challenging, perspective for future research.

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Appendix: Key information on empirical studies discussed in the review

Study	Sample (N, student age/grade)	Main objective or research question	Methodology: Research setting	Methodology: Data collection and analysis	Findings
Agosto (2001)	N = 33 (all female), aged 14-15 years	Creating a gender-based evaluation model for selecting websites of high interest for young women.	Female users examined a set of seven preselected test websites.	Literature review and analysis on gender-related preferences, resulting in a working model for selecting websites of high interest to young women. Group interviews with female users aimed at testing of this model. Analysis of the group interviews using iterative pattern coding.	Eight evaluation criteria appeared to be related to gender: social connectivity; flexibility and motility; contextuality; personal identification; graphic and multimedia concentration; collaboration; inclusion; and confidence.
Agosto (2002a)	N = 22 (all female), aged 14-16 years	Examining theories of bounded rationality and satisficing in relation to young people's use of the Web; exploring the role of personal preference in young people's Web-based decision making.	Students explored three preselected websites and freely surfed the Web.	Qualitative: Web surfing sessions and group interviews. Analysis using iterative pattern coding.	Students operated within the limits of bounded rationality, in the from of time constraints, information overload, and physical constraints. Students showed two major satisficing behaviors (reduction and termination). Personal preference played a major role in website evaluation.
Agosto (2002b)	N = 11 (all female), aged 14-16 years	Building a theoretical model of the criteria that young people use to evaluate websites.	Students explored five test sites and freely surfed the Web.	Qualitative: Website evaluation sessions; group interviews. Data analysis using iterative pattern coding.	Confirmation of the theoretical model of young people's decision-making in using the Web.
Bilal (2000)	N = 14 (sample from three classes, based on parental permission), Grade 7	Examining children's cognitive, physical and affective behaviors when they search for information on a fact-based task; measuring their success in finding the information; examining the influence of student characteristics on their success; developing a new measure for quantifying effectiveness and efficiency scores.	Students got a fact-based assignment and used Yahooligans! to find the answer, without receiving further instruction.	Quantitative: Data collection using software that records students' Web activities. Qualitative: Interviews; teacher assessments of student characteristics and a questionnaire.	50% of the children (N = 7) succeeded in finding the correct answer; most children used inefficient search strategies; unsuccessful children used simple navigational styles; student characteristics had minor effects on their outcomes.
Bilal (2001)	N = 13 (sample of three classes, based on parental permission), Grade 7	Examining children's cognitive and physical behaviors when searching for information on an assigned research task; measuring their success in finding the information; examining differences between this study and Bilal (2000).	Students got an assigned research task and used Yahooligans! to find information to compose their answer.	Quantitative: Data collection using software that records Web activities. Qualitative: interviews; questionnaire, teacher assessments of student characteristics, and an Internet/Web quiz.	69% of the children were partially successful in locating relevant information; 31% failed. Children had more difficulty with the research task than with the fact-based task because of a lack of research skills: They were unable to construct meaning from the information and approached the task by seeking specific answers.
Bilal (2002)	N = 15 (sample of three classes, based on parental permission), Grade 7	Examining children's cognitive and physical behaviors when they search for information on a self-generated task; measuring their success in finding the information; examining differences between this study and Bilal (2000) and Bilal (2001).	Students were asked to select topics of interest to search in Yahooligans! and were instructed to find information for this self-generated task.	Quantitative: Data collection using software that records Web activities. Qualitative: Interviews with students; worksheets on which students stated their topic; search results (printouts of relevant information).	73% of the children were successful in finding the relevant information; overall, children were more successful on this task than on the tasks in the two previous studies; children browsed much more than searched by keyword; children's search and browse moves varied by task and by success levels on the three tasks.

Study	Sample (N, student age/grade)	Main objective or research question	Methodology: Research setting	Methodology: Data collection and analysis	Findings
Facer et al. (2001)	N = 16 (case studies focused on families, selected from a survey with N = 855); students in survey aged 9-10 and 13-14 years	Exploring the ways in which computer expertise is acquired and valued by young people outside school and the role played by existing social and software environ-ments in this process.	Children and families were interviewed and observed at home.	Data collection: Semi-structured interviews with children on their own and with family, peer groups, and teachers; interviews with all family members as a group and individually; an observed "computer tour" in which the child showed all aspects of the home computer that he or she actually used; video observation of the child's computer use. Data analysis using a grounded-theory approach.	Acquisition of ICT skills was driven by the ways in which young people considered ICT use relevant to the achievement of other already-existing objectives in their daily lives; this was in contrast to the UK government and school policy in which the huge investment in ICT is driven by persuading young people of the future relevance of ICT skills.
Fidel et al. (1999)	N = 8, Grades 11 and 12	Exploration and analysis of Web searching for homework assignments of high school students.	Students carried out three homework assignments for a horticulture class.	Case-study method using observation, think-aloud protocols, and interviews.	Students were highly focused when searching on the Web, kept exploration to a minimum, and looked for concrete answers; they used swift and flexible search strategies, with a minimum of text reading.
Hirsh (1999)	N = 10, Grade 5	Exploring the relevance criteria and search strategies of elementary school children when they search for information on electronic resources (not only the Web).	Students carried out a research assignment on a self-chosen sports figure, resulting in a written report.	All students were observed and interviewed twice about the resources that they used and the information that they found.	Students exhibited little concern about the authority of the textual and graphical information that they found; they based the majority of their relevance decisions for textual material on topicality.
Hoffman et al. (2003)	N = 16 (from two classes), 6th-grade students worked in pairs (N = 8 pairs)	Investigating the depth and accuracy of students' science understandings; investigating their use of search-and-assess strategies when using online resources via an interface.	Students worked on four science units during a school year within an inquiry-oriented curriculum, with help from trained teachers and an online interface that provided a variety of scaffolds (for pursuing an inquiry as well as for using online resources).	A variety of qualitative methods: Collection of screen activities and student conversations through process video; student artifacts and reports; semistructured interviews with student pairs; classroom video.	Students constructed meaningful understandings, but the depth and accuracy of their understandings varied; students' level of engagement with inquiry strategies, as well as their use of search-and-assess strategies, may be related to the development of their content understandings.
Jones (2002)	N = 100, Grades 9 and 10, biology students	Providing recommendations to teachers who are interested in implementing Internet inquiry projects.	Students worked in randomly assigned pairs on the same inquiry question for an ecology project. Students were divided in two groups: a less structured group of two classes (with less online support and access to the whole Web) and a more structured group (with more online support and access only to limited websites)	Data collection through a variety of methods: student questionnaire, timesheets, fieldnotes, teacher interview, interviews with students, ratings on students' final papers. Data analysis using descriptive statistics, chi-square tests, and t tests	Ratings on student papers in the two groups showed no significant difference. Students in the less structured group made little use of the opportunity to use the Web and explored little; all students were most concerned with finding the correct answer; students in the more structured group were less motivated to use the Internet.
Kafai & Bates (1997)	N = 196, six classrooms in four schools, Grades 1-6	Preliminary study to investigate how elementary school children interact with the Internet.	All classes participated in a project aimed at building children's information literacy skills (searching skills and critical thinking skills) and using a variety of instructional arrangements, all focused on building an annotated directory of websites.	Not mentioned in the article; observation seems to have been the main method of data collection.	All children were able to use websites; older children learned search skills more easily; selecting good sites was difficult for all students; children were reluctant to read and used only titles to decide which site to visit.

Study	Sample (N, student age/grade)	Main objective or research question	Methodology: Research setting	Methodology: Data collection and analysis	Findings
Large & Beheshti (2000)	N = 50, Grade 6	Exploratory study focused on the viewpoints of students regarding questions such as, "How do primary school students see the Web as an information resource?" "How do they decide which site to consult?" and "What problems do they encounter?"	Students were asked to do a research project on a Winter Olympic sporting activity of their own choice; students worked in small groups but made individual assignments (a poster about the sport); students freely surfed the Web.	Exit interviews with students, with open-ended questions designed to gather data about the children's assessment of the Web in general and of their own searching experiences.	Students' information seeking relied heavily on browsing; the students had difficulties in using the right search terms and finding relevant sites. Students overall liked using the Web; they were uncritical about the information content on the Web; they expressed knowledge of the differences between the Web and print sources.
Large et al. (2002a)	N = 23, aged 10-13 years	Gathering user feedback on various aspects of portal interface design; exploring design criteria for Web portals intended for use by students between the ages of 10 and 13 years.	Four Web portals intended for use by children were selected; children were divided in four same-sex focus groups; all groups searched all portals with the same four questions and commented on the portals.	The four focus group sessions were captured on audiotape, which was transcribed, together with written observation notes; data were categorized by portal and then examined to establish respondents' first impressions, opinions, and suggestions.	Analysis of the children's comments pointed to several recommendations for portal designers: A portal should cater to both educational and entertainment needs, use attractive screen designs, provide both keyword search facilities and browsable subject categories, and allow individual user personalization.
Large et al. (2002b)	N = 44, working in 16 groups (six boys' groups and ten girls' groups), Grade 6	Exploring gender differences in collaborative Web searching; examining whether boys' groups behaved differently from girls' groups online and if so, how their behavior was different.	See Large & Beheshti (2000); students worked in same-sex groups.	Case study using video capture of the search process of students; student actions were quantified using three categories (analytic searching moves, browsing moves, information gathering); statistical analysis for group comparison.	On average, boys engaged in all Web-based activities more than girls; boys also used fewer words to formulate queries than girls; boys spent less time viewing Web pages than girls; girls tended to use more natural language than boys.
Lorenzen (2001)	N = 25, Grades 10 and 12	Exploring how high school students use the Web for school assignments and how they evaluate information that they find on the Web.	Students were selected and interviewed in one high school library and one university library.	Interviews with individual students, focusing on the ways that students use the Web for research assignments.	Students used a variety of resources for school assignments, including the Web; students had difficulties determining the quality of the information they found on the Web and did not know how to evaluate website information.
Lyons et al. (1997)	N = 8 , four 9th-grade students, four 6th-grade students	Exploring the use of the Web for student-generated questions in science classes, the strategies that students employ, and the problems that they encounter.	Students worked in pairs on a science unit, doing research on their own questions and using online scaffolds.	Data collection using process video, resulting in an exact recording of what students do and say while using the computer; classroom observations, informal conversations, field notes.	Students needed much support when working with online resources, both when "doing inquiry" and when using the Web as an information resource Conclusion: the classroom culture needs to be structured in ways that accommodate an inquiry-oriented curriculum.
Mistler-Jackson & Songer (2000)	N = 6, students in 6th-grade (selected from a class where N = 18, on the basis of a motivation questionnaire)	Illustrating how students with different achievement levels and motivational attitudes view learning science and the use of technology both before and after a technology-rich program.	Students took part in an Internet-rich science program for middle schools (Kids as Global Scientists, KGS), in which students use an inquiry-based curriculum and an Internet software program to study general weather topics.	Case study with field observations, videotapes, e-mail correspondence transcripts, individual interviews with students and teachers, and written assessments; motivation questionnaire for the selection of focus students.	Students acquired both learning and motivational benefits through participation in KGS; students found the learning environment an enjoyable way to investigate and learn about their own science questions.

Study	Sample (N, student age/grade)	Main objective or research question	Methodology: Research setting	Methodology: Data collection and analysis	Findings
Ng & Gunstone (2002)	N = 19, Grade 10 (aged 15 years)	Research question: How do students perceive the effectiveness of the Web as a research and teaching tool in their construction of knowledge?	Students performed a self-directed learning task focused on constructing their own conceptual understanding of photosynthesis and respiration by using Web resources; students were free to use the Web.	Questionnaire on students' use of the Web in their learning; measurement of student learning with regard to photosynthesis and respiration through a pretest and posttest.	Students' reflective responses showed increased student motivation and empowerment in terms of ability to take responsibility and control over one's learning; students were aware of the limitations of the Web.
Schacter et al. (1998)	N = 32, Grades 5 and 6	Increasing the understanding of children's information-seeking performance and process behaviors during Web searches under varying task structures.	Students completed two tasks (one ill defined and one well defined) on the subject of crime in California, using the Web as information resource.	Analysis of information-seeking process behaviors by collecting computer trace data for each student search; analysis of information-seeking performance through measurement of all documents found.	Process: Students were interactive information-seekers, preferring browsing to searching strategies. Performance: Students had difficulties in finding relevant information; they searched more effectively on the ill-defined task than on the well-defined task.
Songer et al. (2002)	N classes = 19, N teachers = 6, N students = 423	Examining patterns present across classroom learning environments, actual curricular enactment, and student learning in urban schools taking part in Kids as Global Scientists (KGS), an 8-week inquiry weather program (middle school, technology-rich); examining the role that technology plays in these patterns.	Students took part in an Internet-rich science program for middle schools (Kids as Global Scientists, or KGS), in which students used an inquiry-based curriculum and an Internet software program to study general weather topics; students did not surf freely on the Web.	Pre- and post-science content assessments, classroom observation forms, teacher interviews. Quantitative data referred to student learning outcomes; qualitative data referred to case studies of each classroom and each teacher.	Significant learning results occurred in all classrooms; constraints such as large class sizes, inadequate time, and limited instructional freedom affected these results in a negative way; Internet technology played a significant role in the learning results
Valentine & Holloway (2002)	N survey students = 753, aged 11-16 years N schools = 3, N case study students and families = 40	Providing primary empirical material to show how children use, encounter, and interpret online ("virtual") spaces in the context of their off-line ("real"), everyday worlds.	Survey children were asked about their use of computers and the Internet both at home and in school; case-study classes were observed with a view to children's computer experiences in the school environment; families were interviewed about various aspects of the use of computers and the Internet at home.	Questionnaire survey of 753 students; observations in case-study classes; focus-group discussions with students; semi-structured interviews with information technology teachers and head teachers of the case-study schools; in-depth interviews with students and their parents.	The real and virtual worlds of children appeared to be mutually constituted. Aspects of the real world were incorporated in the virtual world and vice versa; Conclusions: children's use of ICT is embedded in their lives, and their online identities are no less real than those encountered off-line; computers do not have any universal effects but emerge as a different tool for different "communities of practice."
Wallace et al. (2000)	N = 8 (students working in pairs, N pairs = 4), Grade 6	Exploring how students interact with the Web and how they use standard tools.	Students worked in pairs and used the Web to carry out an inquiry-based assignment for an ecology unit, i.e., answering three self-generated research questions on ecology.	Video records of students' online activities; audio recordings of their conversations during these activities; student journals.	Students used the Web easily but simplistically; information seeking appeared to be a complex and difficult process for students; students sought to reduce the task to finding an obvious answer or a good website Conclusion: developing students' understanding of content through use of the Web requires a long-term commitment to inquiry-based learning.
Watson (1998)	N = 9, Grade 8	Examining students' perceptions of their experiences in using the Web, to offer insight into and understanding of the ways that students seek and retrieve information on the Web.	Students were interviewed individually in the school media center.	Narrative analysis of the content of students' transcribed interviews.	Students showed positive attitudes and high levels of confidence in using the Web, but only with using it as a mechanism; few students mentioned having evaluated websites for accuracy and adequacy; students tended to read superficially and forgot to read deeply for meaning and evaluation.

Part II

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Introduction

Introduction Part II

In Part I, we argued for further research on supporting students' Web use and on the design of learning environments in which learning to use of the Web is incorporated into a curricular context. That chapter also provided suggestions for the learning goals for such learning environments. In this second part of the thesis the results of our empirical research are presented. We developed two programs which both aimed at teaching students critical Web skills and strategies within the context of a content knowledge domain. Literature warns against students learning isolated skills without a context and without the need to use those skills and strategies. In two case studies we evaluate these programs with regard to a) the way teachers and students worked with the programs and the contextual factors that influenced the realization of the program, and b) the learning gains in the participating classes in terms of content knowledge and Web literacy skills. These two case studies are presented in chapter 2 and 3 respectively. In a concluding in-depth study we focus exclusively on a selected population of students, investigating their use of Web strategies after the programs, to determine the specific characteristics of (in)adequate strategies. This study is presented in chapter 4.

1_ Teaching Web literacy skills and strategies: two programs

From the literature reviewed in chapter 1, we inferred three main components of critical Web skills: searching for Web information, reading Web information and evaluating Web information. These three categories of subskills are summarized by the umbrella term 'Web literacy', which, in turn, may be viewed as a component of the concept information literacy mentioned in chapter 1. Paraphrasing the definition of information literacy given in chapter 1, Web literacy may then be regarded as the ability to recognize when the Web is needed as an information resource and to effectively locate, evaluate, and use the needed Web information.

The literature reviewed in chapter 1 also formulated a preference for integrating the acquisition of critical Web skills in the context of a content knowledge domain. We designed two equivalent programs with different underlying views and different ways of accomplishing similar learning goals. In both programs, the overall theme was 'healthy food'. One program aimed at teaching Web literacy skills in a method-like way, with prestructured lessons and students working with the same prescribed exercises. This program was relatively easy to implement and thus suitable for a broad range of schools. We named this the **sequential alternative**. The other program we named the **inquiry-based alternative** and aimed at incorporating the acquisition of Web literacy skills within collaborative inquiry activities guided by students' own research question. This program fits in with the preference formulated in chapter 1 for an inquiry-oriented curriculum as a context to the acquisition of critical Web skills because in such context these skills have a natural function as a means for answering queries. In our empirical research, we also wanted to investigate whether such a curriculum is, in fact, an appropriate way to teach such skills. We will first give a short general description of both programs. In the next section, we will describe their differences and similarities with help of five underlying principles. In chapter 2 and 3 the lay-out and content of each program separately will be discussed in greater detail.[10]

The **sequential program** consists of eight weekly lessons. Each lesson is described in detail in a teacher manual and consists of an introduction/class discussion, students working independently (in pairs) at the computer with help of a workbook, and discussion afterwards in which the teacher repeats central elements of that lesson and discusses students' problems. All students' exercises concern the theme

[10] Both programs and the workbook used in the sequential program can be accessed at:
http://www.psy.vu.nl/fpp.php/departments/theoryandresearchineducation/people/details.html?pub=1&id=412

'healthy food'. While the first five lessons focus on Web searching, reading and evaluating respectively, in the last three lessons students need to integrate and apply these skills in more broad and open assignments on three aspects of the theme.

The inquiry-based program consists of ten weekly class meetings.[11] The emphasis is on learning in a community and working in pairs, small groups and the whole class alternate. The students share a joint purpose: composing an information brochure about healthy food for fellow students and parents. All students contribute to the brochure by composing their own research questions, searching for information on the Web and processing this information. With help of a teacher manual, the teacher embeds the teaching of Web literacy skills and strategies within the class project, by way of class discussions, specific assignments as well as continuously relating students' Web activities to the need for specific skills involving Web searching, reading and evaluating, in order to be able to compose a useful, informative and reliable brochure.

2_ Design of the programs: five underlying principles

Both programs used constructivist learning principles, albeit in different interpretations, using the distinction explored by (among others) Cobb & Yackel (1996) between a constructivist and a social constructivist perspective. In the former, the focus is on learning as individual independent activity, taking place in a particular classroom context. In the latter, "learning is a constructive process that occurs while participating in and contributing to the practices of the local community" (p.185). Thus, the sequential program can be described as constructivist since it starts from students working independently and actively with exercises that focus on learning and applying Web literacy skills. The inquiry-based program uses a social constructivist approach given the assumption that both the teaching and learning of these skills occur in collaborative activities in which all students participate, and that the process is aimed at contributing to a meaningful goal. Through joint reflection on the information seeking process, students acquire insight into the function of the information found through the Web, and co-construct meaningful knowledge with help of these collaborative inquiry activities.

[11] The difference in number of lessons between the sequential program (eight lessons) and the inquiry-based program (ten lessons) is explained by the need for thematic starting activities in the latter (e.g., with a view to composing research questions). These lessons did not focus on Web literacy skills or building content knowledge.

Table 1 summarizes the main characteristics of both programs with respect to five categories on which the programs vary: teacher and student roles, structure of the learning process, context and content, the meaning of 'social', and structure and position of learning materials. We will discuss each category more elaborately.

TABLE 1: UNDERLYING PRINCIPLES OF THE TWO PROGRAMS

	Sequential program	Inquiry-oriented program
Teacher and student roles	Teacher and student each have their own role and task: the teacher stimulates students' self-regulated and active learning; the students independently perform Web exercises	Teacher and students together are responsible for building knowledge; the teacher supports students' inquiry activities and interweaves them with teaching Web literacy skills
Structure of the learning process	Structure of learning process is given in advance; all students perform the same exercises at the same time and in the same order	Structure of learning process is partly given in advance and partly develops during the project (through students' research questions and Web activities)
Context and content	The lessons have a common theme; that primarily serves as a stepping stone for learning Web literacy skills	The common theme is the context for students' inquiry activities; students pursue their own interests within that theme through their research questions
Meaning of 'social'	Students working in pairs at the computer merely for practical reasons	Students working together is seen as essential for learning to take place
Structure and position of learning materials	The prestructured learning material guides the students' activities	Learning materials are partly developed during the project since they are based on students' own research questions

Teacher and student roles. In both programs, the teacher introduces the common theme behind the 'healthy food' projects and gives instruction on Web literacy skills with the aid of class discussions. In the sequential program, the teacher's role consists, besides instruction and supervision, of stimulating the students' self-regulated and active learning (Vermunt, 1992). The students work independently in pairs on computer exercises which focus on acquiring the various Web literacy skills and are responsible for the students' own knowledge building. In the inquiry-based program, teacher and students are jointly responsible for building and sharing knowledge (Crawford, Krajcik & Marx, 1999). The teacher has a specific role in interweaving the various inquiry and Web literacy skills within students' inquiry activities. The teacher also scaffolds the students' inquiry activities by helping them to formulate and modify research questions and by modelling an inquisitive attitude (Volman, 2005).

Structure of the learning process. In both programs, the main learning goals are laid out in advance, especially with regard to Web literacy skills. All students successively discuss and practice various subskills and are asked to combine these

skills when searching the Web for either an assignment (the sequential program) or their own research questions (the inquiry-based program). In the sequential program, the intended learning processes are laid out in advance through offering common and fixed learning materials. In the inquiry-based program, the intention is for learning processes to occur as a result of students being confronted with the need for new tools (i.e., knowledge and skills) in order to be able to use Web information for their research questions (Van Oers, 2005). The teacher tries to structure and direct the activities in ways that ensure the result.

Context and content. Both programs have a common theme, 'healthy food', whereby the teaching and learning of Web literacy skills are embedded within the context of a content knowledge domain. In the sequential program, this theme is primarily meant as a steppingstone for learning Web literacy skills through exercises that partly concern general information on healthy food and partly the students' own food habits. The students have minor opportunities to pursue their own interests within that theme. In the inquiry-based program, the theme is the context for the students' collaborative inquiry activities and provides a meaningful goal for those activities, since the students together make a information brochure about healthy food for fellow students (Wells, 2000). The content of the theme receives its shape through students' research questions and may therefore vary between classes.

The meaning of 'social'. Using the analysis of Salomon & Perkins (1998) of different meanings of the social aspects of learning, the sequential program may be characterized as a social learning system in the sense of enabling an individual to acquire knowledge and skills effectively. Students work in pairs, but this merely has a practical reason and is applied only to the students' computer work. In the inquiry-based program, collaboration both between students in pairs or in the whole class, and between students and teacher is seen as essential for learning to take place. The emphasis is on the joint construction of knowledge and on fostering mutual understanding (Salomon & Perkins, 1998). Students share knowledge together, with a view to the common product, for example through class discussions about their work for the brochure or through shared computer documents.

Structure and position of learning materials. In both programs, the teachers have a manual at their disposal in which the program's learning goals as well as the specific layout are explained. Also in both programs, students also receive worksheets that function as tools for supporting and scaffolding their acquisition of Web literacy skills. In the sequential program, the students have a workbook with exercises that is designed as a method. The workbook guides the students' activities by presenting all students with the same exercises in the same order. The teacher manual also provides detailed descriptions of all lessons. In the inquiry-based

program, the learning materials are less prestructured since students' own research questions have an important role within the materials; the precise content of the healthy food-theme is also determined by these questions. In the teacher manual, the focus is on helping teachers to scaffold and model students' inquiry activities with a view to the collaborative production of the brochure, as well as on providing detailed examples of possible lesson procedures.

When designing the programs, we aimed at an optimal degree of comparability. Both programs must be seen as equivalent, having the same learning goals and the same topic. Both were designed as projects evolving over an eight to ten weeks period. In both programs, the same Web literacy skills were introduced and discussed in the classrooms in a comparable way. This comparability provided the possibility to compare and contrast both programs with respect to the way they were carried out as well as students' learning results.

All teachers participated in a preprogram training course, in which the learning goals and layout of that specific program were considered, as well as the content of the various lessons. The teachers were also invited to practise the teaching materials during this course. All students completed a lesson on Web use before the start of the program, in which technical and navigational skills were practised, in order to provide a common base with regard to such skills.

In the next two chapters we present more detailed information about from and content of both programs, for example, the layout of the lessons and the Web skills and strategies that constituted the core of these lessons.

3_ Design and setting of the studies

Our study of the two programs was primarily meant to be explorative since there is little empirical research on teaching Web literacy at primary school level. Explorative research is used to seek insight into little-understood situations and to generate ideas for future research (Robson, 2002). Thus, we aimed at exploring how Web literacy skills can be taught at primary school level. The main questions with regard to both programs were whether teachers could work with the program in the intended way and whether the programs produced the desired learning results.

We used a case study design. Case studies are suitable for investigating a phenomenon within their real-life contexts (Yin, 2002). The surplus value of case studies lies in the extension of the experience it offers (Stake, 1994) rather than in generalisation. We aimed at acquiring insight into the situational conditions as well as into the processes involved in teaching and learning in both programs. The case studies in our research may be described as instrumental (Stake, 1994) since the cases were studied to obtain insight into the ways Web literacy skills can be taught.

Together, they made up a multiple case study (Yin, 2002), consisting of two alternative programs each studied in four different class contexts.

The participating schools will be described in the next two chapters. We aimed at a variety of schools and teachers with respect to both programs, to be able to study the programs in various class contexts. There were however certain common characteristics, which we formulated as conditional on participation in our study. The schools needed to have good ICT facilities at their disposal as well as a sufficient number of computers to allow all students to work in pairs at the computer simultaneously. Because of the time investment by the teacher with regard to both the program itself and participation in the research, the teacher's acceptance of the learning goals and layout of the program was also important. Given the different assumptions of the two programs, we searched for schools with educational views that fitted in with either the program's sequential or the inquiry-based learning principles, as discussed before. As a result, the four teachers working with the sequential program shared a rather traditional, method-based and teacher-centred view on education, while the four teachers working with the inquiry-based program shared a focus on collaborative work and student initiative. With respect to teacher experience and student population in terms of general ability level and ethnic background, we aimed at diversity within both programs, in order to be able to study each program in a variety of contexts. There was, however, an unintentional effect in aiming at two groups of schools with different views on education. The two groups differed considerably with respect to reading level and ethnic and socioeconomic background of the students. On the whole, the classes that participated in the inquiry-based program had (much) fewer students from non-Dutch ethnic and/or lower socioeconomic background and higher mean reading comprehension scores than the classes that participated in the sequential program. Because of these differences between student populations we did not aim at comparing the learning results of both programs. In chapters 2 and 3 we report on the evaluation of the sequential and the inquiry-based program subsequently.

In chapter 4, we take a different approach and focus solely on the students' post-program application of the various Web skills and strategies that were at the centre of the programs. In chapter 4 we no longer focus on the two programs separately. The students studied consist of a selection of student pairs from all participating classes who all made six assignments unconnected to the healthy food-theme. The assignments were designed to assess students' use of Web searching, reading and evaluating skills and strategies in either free Web searches or with regard to specific websites. A first analysis of students' Web use during these

assignments is presented in the chapters 2 and 3. In chapter 4, we use an exploratory approach, in order to systematically reveal characteristics of students' Web strategies that may explain when and why students use the Web adequately or inadequately. In such way, we aim at further conceptualizing Web literacy, as well as at providing further suggestions for teaching Web literacy skills and strategies.

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Chapter 2

Integrating critical Web skills and content knowledge: development and evaluation of a 5th grade educational program[12]

Although the Web is almost omnipresent in many children's lives, most children lack adequate Web searching skills as well as skills to process and critically evaluate Web information. In this article, we describe and evaluate an educational program that aimed at acquiring Web skills in the context of a content knowledge domain. Through a multiple case study design we wanted to gain insight into the contextual factors that influence the realization of such program and into the learning gains in the participating classes in terms of content knowledge and Web skills. Four 5th grade teachers carried out the program, which consisted of eight weekly sessions and focused on teaching students Web searching, reading and evaluating skills within the subject of healthy food. Data from a variety of sources were collected: videotaped and written lesson observations, interviews with teachers and students, teacher diaries, student questionnaires and student assignments. The results show that the teachers appeared to be able to carry out the program to varying degrees. Contextual factors that influenced the realization of the program were partly related to specific conditions as the investment of time and effort by the teacher and the school's way of organizing computer work and its supervision. The extent to which teachers' teaching styles corresponded with the program's assumptions also played an important role. Students' knowledge and skills improved during the program with regard to both content knowledge and Web skills. However, most students appeared to remain inconsistent Web users, and did not act upon their knowledge of Web searching, reading and evaluating skills. Although generally speaking there were differences between stronger and weaker performing students, all students showed unexpected, inconsistent or inflexible behavior.

[12] Kuiper, E., Volman, M. & Terwel, J. (in press). Integrating critical Web skills and content knowledge: development and evaluation of a 5th grade educational program. *Computers in Human Behavior*.

1_ Introduction

It is impossible to imagine children's lives today without the Web. They use it for gaming, for instant messaging and downloading their favourite music. They are also adept at becoming Web authors themselves by constructing their own websites. Children often perceive the Web as a user-friendly resource because it contains a great deal of information as well as pictures that are not only easily accessible, but can be downloaded and relocated for their own purposes. Also at school, many students use the Web; primarily as an information resource, but also as a means of communication and sometimes as a learning environment.

The Web certainly is a potentially useful supplement to the educational tools traditionally used in the classroom. However, it has not been designed for use by children, nor for use in educational settings. Moreover, teachers often perceive children's Web skills as better than their own. Children's navigational skills often are, but when it comes to searching, processing and evaluating skills the picture is different. There is ample research showing that, although children may be confident Web users, they often do not have sufficient Web skills at their disposal. Most children lack adequate Web searching skills, as well as skills to process and critically evaluate Web information (e.g., Bilal, 2000; Fidel et al., 1999; Lorenzen, 2001; Schacter, Chung, & Dorr, 1998; Shenton & Dixon, 2003; Pritchard & Cartwright, 2004). As a result, searching for information usually leads to insufficient knowledge, understanding, and insight.

Researchers and practitioners from both library and information science (LIS) and educational science recognized this problem. Library and information specialists have a long tradition in studying the interaction between information resources and their users. Children's Web information seeking behaviour has been addressed regularly in recent years. Most studies focus on students' search processes, i.e. the collecting of information. However, the subsequent phase of processing the information is often not addressed (Kuiper, Volman & Terwel, 2005). Many authors themselves have pointed out this lacuna. Bilal (2002), for example, mentions the ways children's information seeking on the Web may lead to meaningful learning, as an important question for future research.

Educational researchers, on the other hand, are not primarily interested in Web searching processes as such, but in the ways in which the Web may be used for educational goals (e.g., Hoffmann, Wu, Krajcik & Soloway, 2003; Jones, 2002; Wallace, Kupperman, Krajcik & Soloway, 2000). The Web is seen as a new learning tool that offers new possibilities, but also new challenges for education. Research is focused on the conditions for using the Web as an information resource in the classroom. In such approach, students' lack of Web skills often is countered by

offering scaffolds such as a preselection of websites on a certain subject matter (e.g., Jones, 2002) or interfaces that guide students through inquiry activities on the Web (e.g., Hoffman et al., 2003). One could argue that while LIS research focuses primarily on the Web **skills** children should acquire, educational research is also much concerned with the **products** of Web use, i.e. content knowledge children should acquire through using the Web. More recently, reading researchers focusing on reading comprehension processes, have looked more closely at the differences between Web and print reading processes and the searching, reading and processing skills that are conditional for using the Web for knowledge construction (Coiro, 2003; Leu, Kinzer, Coiro & Cammack, 2004).

Although there is rather ample research on both children's Web search behaviour and the way the Web may be used as an educational tool, empirical research on teaching Web skills is relatively scarce and mostly aimed at upper grade and university students (e.g., Walton & Archer, 2004). However, teaching Web skills is necessary already at the primary school level because children themselves use the Web at a young age. Many schools recognize this need, as is reflected in the abundance of examples of worksheets and lesson plans that can be found on the Web. These 'good practices' mostly refer to certain fragmented aspects of Web skills (e.g., worksheets with practical guidance to help students assess the usefulness of a specific website) and in general are not based on research. By exploring possibilities for creating novel teaching and learning environments with regard to teaching Web skills at the primary school level, our research wants to fill the gap between these 'good practices' and theoretical notions on how children should learn to cope with all difficult aspects the Web implies (e.g., Burbules & Callister, 2000; Frechette, 2002; Snyder, 2002). In this article, we describe and evaluate an educational program that aimed at acquiring Web skills in the context of a content knowledge domain. We wanted to explore the possibilities for teaching Web literacy skills in an integrated way during one course in which students practised these skills within one such domain (i.e., 'healthy food').

In our research, we use the term 'Web literacy' to refer to the ability to handle the Web critically. Web literacy is in fact an umbrella term that comprises a combination of various skills regarding the critical and meaningful use of the Web. LIS and educational researchers, as well as reading researchers have elaborated which components such critical Web use could encompass, the former two mostly starting from notions from empirical research (e.g., Bilal & Kirby, 2002; Brand-Gruwel, Wopereis & Vermetten, 2005; Enochsson, 2005; Fidel et al. 1999; Shenton & Dixon, 2003), the latter also referring to more theoretical notions on differences between reading print and Web information (e.g., Bruce, 2000; Coiro, 2003; Leu,

2002; Snyder, 2002). In general, all agree that the size and topicality of the Web imply that students must have good searching skills to be able to find what they are looking for. They also must be capable of making decisions on their own information needs. The Web's accessibility implies that students must be aware of its negative sides and learn to cope with such negative aspects. The use of hypertext makes high demands on critical reading skills because it invites the reader to follow his or her own path through Web texts. The multimodal character of the Web requires specific skills to be able to 'read' all sorts of non-textual information elements as illustrations and animations and to relate these elements to textual information. For the benefit of our research, we distinguish three principal subcategories of skills: Web searching skills, Web reading skills and Web evaluating skills. Searching skills include for example the ability to define appropriate key words and locate relevant information. Reading skills comprise for example, the ability to handle hypertext elements and to explore great amounts of diverse information, as well as knowing what information to use and explore and what to ignore. Evaluating skills include the ability to assess the relevance, reliability and authority of Web information.

In our research on teaching Web skills, we take an interdisciplinary approach. We try to combine the focuses of LIS and educational research in designing educational programs that aim at teaching both Web skills and content matter. LIS researchers argue that children need to be taught relevant Web skills to grow into competent information literate persons. However, educational researchers are right in emphasizing the importance of knowledge and insight as products of all information seeking processes. We think there certainly is a task for education in both respects.

In looking for ways for schools to fulfil this task, we argue from socio-constructivist theories on teaching and learning. Socio-constructivist theories suggest that students should be activated to construct their own knowledge, building on what they already know and can do. Constructing knowledge is seen as a preferably non-individual activity; collaboration with fellow students can enhance knowledge building, since it challenges students to assume an active role (e.g., Van der Linden, Erkens, Schmidt & Renshaw, 2000). The role of the teacher in constructivist teaching no longer lies in the transmission of knowledge, but in providing students with support in their learning processes. This is reflected in alternation of teacher-guided instruction, whole class discussion and students working individually or in groups. Elements of constructivist learning environments are the centrality of an ill-defined, authentic problem that drives student learning, teacher support through modelling, coaching and scaffolding, and the use of a variety of learning tools (Jonassen, 1999).

When connecting these learning principles with the aim of teaching critical Web skills, we want to argue that within socio-constructivist ways of teaching, skills are acquired within a relevant and meaningful context. As a consequence, students should not be taught Web skills through isolated assignments or worksheets that treat these skills as separate entities, as is practice in many schools. By embedding the teaching of Web skills within teaching and acquiring content matter, the intention is that these skills become meaningful for students. Students should foremost gain insight in the connection and interrelatedness of these skills, as well as their functionality. Although randomly surfing is a preferred activity by both children and adults, at school children have the opportunity to experience the advantages of using Web skills.

We designed an eight weeks program for 5th grade teachers and their students (aged 10-11 years old) on the subject healthy food. In the lessons, the teachers offered the students instruction on Web searching, reading and evaluating skills. The students got structured assignments to practice these skills; all assignments focused on aspects of healthy food and used or required the use of websites on this subject. The teachers also discussed both the Web skills and the subject with the students.

By studying the program in four different class contexts, we expected to gain insight into the contextual factors that may influence its possibilities and limitations. The evaluation of the program, being explorative in nature, was guided by the following research questions:

a. How do the teachers implement the program and how do contextual factors influence the realization of the program?

b. What are the learning results of the program in the participating classes in terms of both content knowledge and Web skills?

2_ Method

2.1 Participants and Setting

Four 5th grade teachers (three male, one female) from four different schools and in total 82 students participated (43 male, 39 female; mean age 10.4 years). The classes that participated in our study differed in aspects as class size, teacher experience, teaching style, teacher's Web skills, the students' ethnic and socio-economic background and their reading ability. All schools shared a more or less traditional view on education, which can be described as being rather teacher-directive, working with fixed curricula, and little experience with collaborative

learning and project work. All schools had ample ict facilities and both teachers and students were used to working with all sorts of ict applications. Although the teachers differed with respect to their own Web skills, all were convinced of the value of teaching Web literacy skills. They also were willing to extend their own teaching practice by participating in our research, which asked them to practice a more socio-constructivist teaching style. With regard to the participating students, classes differed significantly in two respects, i.e. the main language spoken at home and the parents' native country. There were no significant differences between the classes with regard to Internet connection at home, the time students spent at the computer at home, self-reported Web skills and their preference for either books or the Web as information resource for school assignments.

Acton School[13] is situated in a town's suburb. Most of its students come from lower class Turkish or Moroccan families. The participating class of 14 students (5 girls, 9 boys) also has some white lower middle class students and a refugee from Afghanistan. The school has good ict facilities; in the participating class students have six computers at their disposal that are placed in the classroom. Their teacher Nigel is a very experienced computer and Web user himself. The school has a traditional view on education, with much attention on providing clear structure and guidance for the students. Nigel has worked at the school for five years and welcomes the project as an opportunity to practice project work and stimulate student collaboration. His students are weak readers; their average reading comprehension score is 39.0, which is far below the national average of 49.0.[14] Several students are subject of the teacher's concern because of their problematic behaviour. The teacher hopes to establish a safe learning environment for all students by being very strict in certain class rules and by expecting students to behave according to these rules.

Barnton School is located in a town's suburb. Its student population is mixed: many white, lower middle class and middle class children but also students from various other origins (Surinam, Turkish, Moroccan). The school has rather traditional views on education. The use of ict is integrated in the school curriculum and the students are used to work with the computer in several ways. Mike, the 5th grade teacher who participated in the study is a trainee teacher in his last year of training. He teaches the students for two days a week, under supervision of an experienced teacher who is absent in the classrooms most of the program's lessons. Mike has a

[13] Names of schools and people have been changed to ensure anonymity.

[14] Derived from a standardised Dutch National School Achievement Test (from the CITO, the Dutch National Institute for Test Development).

lot of ict expertise but is of course less experienced in didactical matters. His class of 31 students is a difficult class to work with because of a lot of animosity between students, especially the boys. Some students have rather serious behavioural problems. The problems in the class became of such nature that the school principal decided to split up the class. As a result, one half of the class was not able to finish the program because they got a new teacher. Mike completed the program with the 16 students that stayed in his part of the class (6 girls, 10 boys). Their average test score on reading comprehension is 44.7, which is below the national average.

Calmore School is situated near the centre of the same town as Barnton School. Most students come from white lower and middle class families. The school has good ict facilities; the computers are situated in the corridor outside the 5th and 6th grade classrooms. As in Barnton School, classes are divided in two during computer lessons, half of the students are staying in the classroom. Mary, the 5th grade teacher has 25 years of teaching experience. She sees herself as an ignorant computer and Web user and invested a lot of time during the program in practicing her own computer and Web skills. Her class of 26 (15 girls, 11 boys) has a lot of active students who like to participate in all sorts of class activities. Their average test scores on reading comprehension are 49.4, which is around the national average of 49.0.

Dunham School is situated in a village. Most students are from white upper middle class families. The school has good computer facilities; computers are situated in an open space near the classrooms. Charles, the 5th grade teacher has five years of teaching experience at this school. His teaching style is rather directive and strict and he expects students to behave polite and to obey class rules. He is rather experienced in using the computer and the Web in his teaching. The participating class (13 girls, 13 boys) has an average reading comprehension score of 45.4, which is slightly below the national average, but there is much diversity between students.

2.2 Materials

The educational program

The educational program comprised 8 weekly lessons of 1,5 to 2 hours each. The program had one overall subject, 'healthy food', which was chosen both because of its connection with children's everyday lives and because of the opportunities for acquiring relevant Web skills. Being a broad, interdisciplinary subject related but not restricted to the schools' curricular goals, it offered much possibility to acquire and practice Web searching, reading and evaluating skills.

In order to connect the teacher's school context and teaching style with the socio-constructivist starting points discussed in the previous section, we chose to

design a program in which elements of a structured teaching method (e.g., all students practised the same exercises at the same time; the teacher manual prescribed the lessons in detail) were combined with elements such as a great focus on class discussion and on collaboration between students. Moreover, while the first five lessons of the program focused on acquiring Web searching, reading and evaluating skills, the last three lessons aimed at integrating the Web skills and specific content knowledge on the program's subject, healthy food. Table 1 shows the overall structure of the program. The aspects of Web literacy, which were addressed in the lessons, are summarized in Table 2.

TABLE 1: OVERALL STRUCTURE OF THE PROGRAM.

lesson 1	**Web searching skills and strategies**: Instruction into the various Web searching strategies and the skills they require; practise of searching strategies and skills; discussion of the various' strategies possibilities and limitations
lessons 2 and 3	**Web reading and interpreting skills and strategies**: Instruction into various Web reading strategies and their specific use; practice of these strategies; discussion of each strategy's possibilities and limitations.
lessons 4 and 5	**Web assessment and evaluating skills and strategies**: Instruction into various useful criteria for the evaluation of both textual and visual Web information; discussion of the necessity of Web evaluations; practice of applying evaluating strategies on particular websites.
lesson 6	**Web assignment 1: Am I a healthy eater?** Joint application of the Web searching, reading and evaluating skills and strategies
lesson 7	**Web assignment 2: What does a label say?** Joint application of the Web searching, reading and evaluating skills and strategies
lesson 8	**Web assignment 3: Food advertisements** Joint application of the Web searching, reading and evaluating skills and strategies

TABLE 2: ASPECTS OF WEB LITERACY ADDRESSED IN THE PROGRAM

Searching for Web information	- possibilities and limitations of search engines - meaning and proper use of URL's - browsing strategies - formulating key words - navigating through lists of results from search engines - evaluating the relevance of these results - using search strategies in a flexible way
Reading and interpreting Web information	- various ways in which websites may be structured - practising reading of several types of Web texts - using navigational aids such as toolbars and menus - skimming Web texts to identify key words or phrases - in-depth reading of relevant passages - purposeful use of links in Web texts

Assessing and evaluating Web information	- assessing one's own level of understanding of specific Web texts - getting insight into the relative accuracy and reliability of Web information - judging the accuracy and reliability of Web information - relating the information found on one's own question or need for information - assessing the function and meaning of visual website elements

The first five lessons were designed in a similar pattern, beginning with teacher initiated instruction and discussion which was followed by a period in which all students worked in pairs at the computer. The lesson was completed by a teacher led discussion of difficult aspects of the computer assignments and revision of the main learning points of that lesson. In general, the teacher began the lesson with a whole class discussion on the lesson subject. For example, she discussed with the students the ways they searched the Web for homework assignments and their views on several Web searching strategies. In the lessons on Web reading skills she discussed students' opinions on the differences between reading a book and reading on the Web. In a similar way, in the Web evaluating lessons students' opinions on and knowledge of the necessity of those skills was subject of class discussion. Both during and after these class discussions, the teacher gave instruction on the Web skills that were the focus of that particular lesson. After this instruction, students worked in pairs at the computer for about 45 to 60 minutes. All student pairs had their own workbook with assignments and background information about the several Web skills. All assignments were on the program's overall subject 'healthy food'. The teacher supported students when necessary. After the computer time, the teacher discussed with the students their work, focusing on difficult parts of the assignments. The use of a computer projector in these discussions enabled the teacher to model the desired skills and to practice together with the students possible ways to accomplish the assignments. As can be seen in Table 1, searching skills were the subject of one lesson, both reading and evaluating skills were dealt with in two lessons. Searching skills were relatively familiar for both teachers and students; the schools paid already some attention to these skills. Reading and evaluating skills were new elements and were supposed to require more lesson time.

The last three lessons were designed differently and aimed at acquiring specific content knowledge on healthy food by using the Web skills in an integrated way. In each of these lessons, the students got an assignment on one particular aspect of healthy food: respectively, the nutrition needs of children aged 10 to 12 years, the information about ingredients and nutritive value on food packings and labels, and advertisements and claims regarding (supposed) food healthiness. In these lessons, we wanted students to use the Web skills they had learned and practiced in the previous lessons and to prevent a mere 'skills approach' in which the various Web

skills would become isolated from the content and daily life contexts in which they are actually used. Therefore, the assignments were connected to the students' home activities as keeping 'eating diaries' and collecting packings and labels of food they had eaten themselves. In these lessons there was also more explicit attention on the appropriation of knowledge on healthy food than in the previous lessons in which the various Web skills were prominent. Students were supposed to search the Web for specific information and had to compose their own text based on that information. For example, in the sixth lesson, they were asked to write a text on the healthiness of their own eating habits. After comparing each other's eating diaries, they had to search the Web for information on guidelines for healthy eating habits of children of their own age. Finally, they were asked to write a text in which they compared their own eating habits with these guidelines. Although all assignments were written out very clearly, the students were supposed to work much more independently than in the previous lessons. They also had much more opportunity to connect their own interests and experiences with these assignments. The teacher discussed these assignments in detail with the students and supported the students during their work.

The teachers had a teacher manual at their disposal in which all lessons were described in detail, as well as their learning goals and the necessary preparation. All teachers received a five hour teacher training course in advance, focusing on aspects as the background and learning goals of the program, the design and content of the lessons and the necessary teaching skills. All student pairs had a workbook at their disposal in which all exercises were written out clearly for them together with helpful tips and background information. The exercises have been tried out by some students of the same age beforehand and adapted when necessary. All teaching materials and student exercises have been discussed with experts in the field of teacher training, Web literacy skills and school advisement.

2.3 Instruments and procedures

A variety of data were collected both on the experiences of the teachers and on the learning processes of students, with a view to an in-depth study of the program. Lesson observations, field notes and face-to-face interviews with teachers were combined with student interviews, student questionnaires, and final student assignments. This variety of data sources also served triangulation of the data.

Lesson observations, field notes, and interviews with teachers

Observation data focused primarily on the teachers' actions and on the dialogue between teachers and students. Every other week a whole lesson was videotaped for each class. In this way, every lesson in the lesson plan was videotaped in two

different classes. All videotapes were transcribed. Diaries with field notes on these same lessons served as supplementary observation data, as well as observation checklists focusing on aspects such as teacher instruction, student involvement, class climate, and the way the teacher supported the students. The field notes served as primary material in initial data analyses, which provided direction for later observations.

Every other week the teachers were interviewed. In addition, the teachers also maintained diaries for all lessons. Both interviews and diaries focused on the implementation of the program and on the students' learning processes. Teachers were explicitly invited to share their opinion of the program with the researchers, and to discuss their experiences. This enabled us to compare our research observations with the teacher's experiences.

Student questionnaires, observations and interviews with students, and final assignment

From the total of 82 students, 76 students filled out a questionnaire both before and after the program. Part of this questionnaire focused on aspects of students' backgrounds and their attitudes towards computers in general and the Web in particular. Another part consisted of 10 knowledge items on the subject of healthy food and 15 knowledge items on searching and evaluating Web information (all multiple choice items). On both subjects, no reliable tests to determine differences between students of this age are available. Kuhlemeier and Hemker (2005), when constructing a broad test on Internet skills for high school students, deliberately left out items on evaluating Web information because of the failure to construct reliable and valid test items on such critical Web use. Therefore, we decided to construct a questionnaire that consisted of items on a range of aspects of healthy food and critical Web use, without aiming at constructing a coherent test that could determine differences between students and between times. This is reflected in rather low reliability scores (α =.55 for items on healthy food; α =.64 for items on critical Web use). With regard to healthy food, some items were directly related to the declarative knowledge students had come across during the program (e.g., "What are ingredients?"); others were meant to give an indication of a general way of thinking critically about eating habits (e.g., "What is the best solution when you eat not enough vitamins?"). The items on Web use focused on searching/navigating skills and (to a lesser extent) on evaluating skills. Web reading skills were not explicitly addressed, as a pencil-and-paper questionnaire can not reflect the complexity of Web reading in practice. Some elements of reading on the Web were imitated by offering screenshots of Web pages on which the students had to choose between links (e.g., "On what part do you click when you want to know the entrance fee of the zoo?").

Furthermore, students' test scores on reading comprehension were used as background information.[15]

In each class, three students pairs were selected and more intensively observed, using an observation checklist that focused on aspects of students' involvement, collaboration between students and the way students worked with the teaching materials. These students were also interviewed every other week. In these interviews students were free to discuss their opinions on the lessons, on what they had learned that week and on the teaching materials. We aimed at diversity between the student pairs, choosing students of mixed gender and ability. After the program was finished, these 12 student pairs carried out six final assignments that all focused on the application of critical Web skills. Although Web searching, reading and evaluating skills all play a role in Web activities, in each assignment one or more of these skills were more prominent than others. In assignment 1 and 2 students were asked to find a specific answer on the Web. For example, assignment 1 asked students to find an answer to the question "What language do the inhabitants of the island Madagascar speak?" They were free to use the Web as they wanted, which made it possible to observe their spontaneous Web searching, reading and evaluating strategies and skills. The assignments differed in level of complexity, assignment 1 being more simple and straightforward, while assignment 2 was more complicated both with regard to the phrasing and the difficulty of finding the right answer. Assignment 3 focused more exclusively on reading skills. This assignment provided students with a specific website (i.e., the website of the Dutch Royal family), and asked them to search specific information on that website (i.e., the names of the children of one of the of the Dutch crown prince's nephews). Searching skills were less important in this assignment. The assignments 4, 5 and 6 focused on aspects of evaluating websites. In these assignments, students were provided with one specific website and asked to comment on an aspect of Web evaluation. Assignment 4 asked students to mention spontaneously positive and negative elements of a website on animal protection (www.dierenbescherming.nl). Assignment 5 asked them to discuss the specific purpose of a website about preservation of Dutch wetlands (www.waddenvereniging.nl), an aspect of evaluating websites that had been prominent in the lessons. Assignment 6 asked students to discuss the usefulness for children of a website about safe Internet use (www.kinderconsument.nl), which appeared to be nice and useful for children, but which happened to be written for parents when evaluating its content.

[15] The knowledge items of the questionnaire can be accessed at:
http://www.psy.vu.nl/fpp.php/departments/theoryandresearchineducation/people/details.html?pub=1&id=412

All students worked in pairs, as they had done during the program. For each assignment, they got a maximum of 10 minutes. All sessions were captured with Camtasia Studio screen recording software, which also recorded the conversations of the student pairs. No technical problems occurred during the assignments, with the exception of assignment 6 which could only be made by the students of the Calmore and Dunham schools because that particular website was 'under construction' on the day the students of the other two schools carried out the assignments.

2.4 Design of the study and data analysis

We used a multiple case study design for our research (Yin, 2002), in which data from a variety of sources were collected and analysed. The same program was implemented in four classes. The first phase of data analysis focused on the within-class description of the implementation of the program in each class. Then, cross-class analysis was performed to determine which contextual factors at the class level affect the realization of the program and students' learning.

Analysis of lesson observations, field notes and teacher interviews

The videotapes of the lessons were transcribed and analysed with a view to characterising the learning environment in each class. Our focal points were:

- the way the teachers gave instruction on the various Web skills and discussed the students' exercises;
- the way teacher and students discussed the various Web skills and the student assignments;
- the way the teachers supported the students during their computer work;
- the way students collaborated;
- students' involvement in the program.

The transcribed videotapes and the written observations were combined on these aspects. Lesson segments were described, highlighting key events, after which each classroom was characterised by identifying what elements were present. Also the way the teacher worked with the provided teaching materials and guidelines was analysed. Transcriptions were also made of all teacher interviews. These transcripts were analysed in two ways: with a view to both the focal points used for the analysis of the observation data, and the teachers' ways of reflecting on their own way of working, on the program as a whole and on the provided teaching materials. The interviews also served triangulation, by comparing and contrasting them with the observation data.

Analysis of student interviews, observations, questionnaires, and final assignments

The transcriptions of the student interviews were analysed with a view to their opinion on the program's materials (e.g., the workbook), on the way the teacher worked with the program, and on the usefulness of the program. The student observations primarily served triangulation, by comparing and contrasting them with the interview data.

Students' answers on the knowledge items of the questionnaires were scored, both for the total group of 76 students and for the four classes separately. We performed T-tests to compare mean scores of the four classes.

The Camtasia screen and audio recordings of the final assignments of all student pairs (n=12) were transcribed. These transcripts provided insight into students' ways of working with the Web as well as their collaboration and discussions. The recordings and transcripts of the assignments 1 and 2 were analysed with the help of a list of Web searching, reading and evaluating strategies the program had paid attention to (see Table 2). All searching, reading and evaluating strategies student pairs used in these assignment were counted. In this first analysis, we used a clear distinction between the three categories; as a consequence, reading strategies were restricted to 'reading on a specific website'. However, reading on the Web concerns not only reading on a website, but also concerns for example reading search engine results. Moreover, using a certain searching or reading strategy does not provide information about its adequacy in the context of a specific task or question. For example, using only one keyword when searching at Google may be adequate in the context of the Madagascar-assignment, but inadequate in the context of another task. Therefore, we designed a coding procedure in which each separate reading and searching activity was first coded and then scored as either 0, 0.5 or 1, depending on its adequacy in the context of that specific task. The reliability of the coding procedure was calculated by coding about 50% of the activities twice, by two independent researchers (Cohen's kappa =.87). Appendix 1 shows the coding scheme, with the definitions used to identify activities and examples. These scores were added up and then divided by the total amount of reading and searching activities each pair had conducted in that assignment. In this way, an overall score (laying between 0 and 1) for each student pair's adequacy in using Web searching and reading skills was calculated.

In the assignments 4, 5 and 6 that focused primarily on students' Web evaluating skills, students did not have to find specific answers, but were asked to discuss the quality, intentions or usefulness of a specific website. We did not score individual student pairs' way of working with these assignments, but wanted instead

to get an overview of all arguments students used as well as their relation with the aspects of evaluating Web information that were discussed in the lessons. The transcripts of the student pairs' dialogue and screen behaviour during the assignments were analysed with a view to this. Jointly, these data provided insight into the Web literacy skills students were able to use, as well as their specific Web search behaviour during the various assignments.

Finally, data from multiple sources (teacher and student observations and interviews, and students' final assignments) were analysed in relation to each other and between classes.

3_ Results

First, a within-class description is presented of the implementation of the program in the four classes. Then, the cross-class comparison will focus on differences with regard to this implementation. Finally, students' learning results will be addressed.

3.1 Within-class description of the implementation of the program

Acton School

Because in this school the computers were situated in the classroom, all student pairs could work together at the same time without any need to go outside. This had several positive effects, e.g. the opportunity for students to finish their work at other times during the week and the teacher's close guidance of all students working together at the computers. This was especially important because for many students the program was hard to work with. Their reading problems forced them to invest much time in finishing all exercises and they also were not used to work in such an independent way. At the same time, they liked the lessons very much: they liked to work with the computer and the Web, and they also felt important as participants in the researcher's work. They were never bored and always glad when program time began and seemed to look at the lessons as an opportunity to learn something new.

Teacher Nigel's teaching style was reflected in the way he organised class discussion and instruction. Nigel started the discussion by asking a question, and either waited for fingers raised, or gave all students one by one a turn. He did not stimulate discussions between students but was very keen on giving all students equal opportunity to answer or say their opinion. Despite his efforts, the boys joined class talk much more than the girls. Many students seemed not being used with discussing their own opinions, which may also be influenced by their difficulties with speaking Dutch fluently. The teacher prepared all lessons well and followed the teacher manual more or less literally. Although it took a great deal of his time during the week, he liked the program because of its learning goals and opportunities for

collaboration. Students also worked much better than he expected; especially their drive to finish the exercises and the way they collaborated surprised him from time to time. After the program, he used the Web more in his lessons and also mentioned the program's Web skills from time to time to the students. In his view, the students had learned a lot during the lessons, although he would have liked to spend more time on the subject healthy food.

Barnton School

Existing problems in this class affected the program from the first lesson on. The teacher (Mike) had to spend a lot of time on troublesome student behaviour that interrupted the lessons. As a result, the lessons often did not work out in the way Mike expected, despite his careful preparation of all lessons. Class discussions were often interrupted or disturbed by conflicts between students. The instruction took more time than estimated and sometimes could not be finished because of time constraints. This was also a consequence of the way computer work was arranged at this school. Classes were divided in two during computer time, with one half working in the computer room and the other half taking lessons from another teacher. This meant a tight time schedule; students could not finish their work at all times because other classes booked the computer room. The problems in the class together with Mike's little teaching experience also were at the expense of the time he could spend on actually supporting students in their work, especially in the computer room. Although some student pairs worked together well, the unrest in the class affected all students in some way. The students did not really become involved in the program (as in any other class activity); they viewed themselves as 'the troublesome class' in which nothing really worked out well.

After the principal's decision to split up the class, the class atmosphere in Mike's half class of 16 students became more positive. As a result, he was able to spend more time on class discussion and on supporting students during their working at the assignments in the last three lessons. After all, Mike is positive about the program, especially with regard to the teacher manual and the content of the lessons. For him, the program not only was a means to practice teaching the students Web literacy skills, but also a way to practice supporting students while doing project activities. However, particularly with regard to the students' workbooks he mentions the problems students have with reading the information and the length of the exercises in the workbooks. For many children in his class who are rather weak readers, it sometimes was too much work to finish a particular lesson's exercises in one computer lesson.

Calmore School

From the first lesson on, teacher Mary took the program very seriously. She prepared the lessons in great detail and made her own version of the lesson plans in the teacher manual. She liked the class discussions during instruction time and took ample time for them. Because of the students' active attitudes, these discussions often became lively and entertaining. From the third lesson on, Mary used a computer projector in all lessons. By doing so, she was able to direct the students' attention to the lesson themes and to illustrate the various skills while demonstrating them on the computer, thereby also modelling students' Web behaviour. Mary also talked about both lesson content and Web skills learned during other lessons. For example, in a biology lesson students recognized information about the necessity of calcium for bone structure as something they had come across during one of the program's lessons. The teacher also connected Web reading skills with her lessons in reading comprehension. Although she was a rather inexperienced Web user herself, she was able to support students very well during computer time, especially with regard to reading and evaluating Web information. Although most student pairs worked well together, the teacher took time to support student pairs with regard to collaboration every lesson.

Although the program was carried out very well in this class, some aspects proved to be difficult either for the teacher or for the students. The teacher found it sometimes difficult to support the students during computer work and to recognize their problems. Some lessons were a bit too long, especially the first lesson on searching skills. She also thought the program as a whole to be too long: after the 5th and 6th week, students became a bit bored with the subject. Both teacher and students commented on the fact that the student materials sometimes were too much elaborated; students had to read a lot during the lessons. Especially for the weaker readers this proved to be difficult. On the whole, Mary was very satisfied with the way the program had worked out in her class. Students not only had learned new and relevant Web skills and had acquired knowledge on healthy food, but in her view also had learned a lot about working together, expressing their own opinions and text composition.

Dunham School

Due to circumstances like illness and other school projects, the program took more time in this class than in other classes. The eight lessons were carried out in a period of twelve weeks. This resulted in fragmentation: students' attention was dispersed and students lost the program's overview. They liked the program because of the opportunity to use the Web, but did not seem to realize what the program was about. This was strengthened by the fact that teacher Charles did not start out

with discussing the program's goals with the students. He either skipped class discussions on healthy food and Web use in the lessons or invested little time in them. This seemed to be part of a more general teaching attitude that was also reflected in the way instruction and discussion of the lessons worked out in this class. The students stayed rather passive because the teacher did not really engage them as partners in a discussion. He was focused foremost on providing students with the 'right answers' on the assignments and on correcting undesirable student behaviour, which resulted in spontaneous remarks not being welcomed as contribution to a shared discussion.

During computer work, the class was divided in two parts, as was also the case in the Barnton and Calmore Schools. However, in this class the teacher had to supervise both the students who worked on their own in the classroom and the students who worked at the computers. This resulted in insufficient student supervision. Some of the students did not work with the exercises at all, but played games on the websites they had to visit. Others got stuck in an exercise or didn't get anything done. Charles was unhappy with this but did not take any action to solve it. In his view, the students were restless and 'difficult', partly because the exercises were too much work and too difficult for them, partly because they gave up easily. Charles was not very satisfied with the way the program had worked out for his class. He still thought the learning goals to be useful and necessary, but preferred shorter lessons that focused more on sub skills and that were easier to work with for students.

3.2 Across-class comparison

Implementing the program: the teachers

Although all teachers had followed the same teaching training course and all had the same teacher manual at their disposal, there were several distinguishing features in the way they implemented the program. To start, working conditions were not comparable for all teachers. Especially at Barnton School the teacher's situation was different because of the problems in his class, which resulted in splitting up the students. His limited teaching experience made the circumstances even more difficult. The teachers also worked with different student populations; especially the students of Acton School differed from others because of their reading problems. Teachers also differed in teaching style, which affected in particular the instruction and class discussions, before and after the computer lesson. The discussions moved in very different directions, from active and lively discussions in which most students participated, to structured question – answer sequences or even no dialogue at all. During instruction, teachers differed for example in their ability to

connect the subjects 'healthy food' and 'Web skills' with their own and the students' everyday lives.

Overall, two of the four teachers seem to have carried out the program's intentions. Both the teachers of Calmore and Acton School put much time and effort in the program. The teacher of Calmore School prepared all lessons in detail and practised all student exercises, so she could support students better and was prepared for their problems. She also took the discussion afterwards very seriously and always used a computer projector during the instruction and discussion. This focused the students' attention and stimulated them to be active and to think along with the teacher. The teacher of Acton School had a different teaching style which resulted in a different class atmosphere and a much more structured and teacher-led instruction and discussion. However, he also took great efforts in supporting students and in stimulating students to finish their lessons. This was especially important because the teaching materials were really hard to work with for his students. Both teachers also took time to discuss the conditions for collaborative working with their students, not only before but also after the lessons.

All teachers succeeded in finishing the program, although one teacher had to spread out the lessons over a longer period than the estimated eight weeks. But all teachers struggled with the fact that the lesson time was barely enough. Lesson introduction, instruction and discussion afterwards took more time than expected, although this also depended on teaching styles and the presence of certain preconditions. Teachers differed in their opportunities to finish a lesson on a later time in the same week, e.g. sometimes there was only a fixed computer time for the students or a teacher worked only part-time. Teachers also differed in the extent to which they succeeded in teaching both critical Web skills and knowledge of healthy food. Especially the teachers of Calmore School and Acton School paid a lot of attention to both types of learning goals. At both schools the teachers sometimes connected the lessons' content to other school subjects, for example a biology or reading comprehension lesson. For them, this possibility proved to be one of the reasons of their positive evaluation of the program. Although they also mentioned a number of shortcomings, both teachers planned to use the teaching materials again next year.

The teacher at Dunham School was rather critical of the program. In our view, this may be related to a discrepancy between the socio-constructivist learning principles that guided the teaching materials and his own teaching style. Both the teachers of Acton and Dunham School can be characterized as teaching in a rather teacher-directed style. However, the teacher of Acton School turned out to be able to work with the program in a way that served both the program's goals and his own

way of teaching in this particular class. For him, the program was a way to try out other ways of teaching, which he welcomed. The teacher of Dunham School, at the other hand, did not seem to be aware of the extent to which his teaching affected the class discussions, students' motivation and their way of working with the program. In this class, the gap between the program's teaching materials and the teacher's own teaching style seemed to be too big.

All teachers had difficulties with the last three lessons, in which students worked on a particular assignment in which Web searching, reading and evaluating skills had to be integrated and applied. In these rather traditionally working schools, many students were not used to composing their own texts or in expressing their own opinions in writing. The teachers suggested to either disconnecting these assignments from the rest of the program, or taking more time to support students and to practice the (writing etc) skills needed before the program. Especially the first suggestion may reflect a difference between the more practical way the teachers approached the program, and our intentions to offer students the necessary integration of the various Web skills that were taught and practiced separately in the first part of the program.

After the program, all teachers stayed at their initial opinion that its learning goals (in terms of both Web literacy skills and knowledge of healthy food) were useful and necessary. They recognized their students' problems with searching, reading and evaluating Web information even more clearly after the program. Especially the students' problems with reading on Web text was mentioned by all teachers: they had seen their students skipping relevant texts easily, getting lost in a website's menus and following links without a clear purpose. The teachers were concerned about the lack of focus and rather 'fleeting' behaviour of many students, even when reading short and easy texts. Moreover, they all mentioned the fact that most students also were weak readers of the texts and exercises in their workbooks, resulting in incomplete exercises. Although this was no surprise for them, the teachers struggled with the necessity of guiding students through the exercises whereas the students were supposed to work rather independently at the computer. Teachers differed in their opinions on what students had learned from the program, the teachers of Calmore and Acton School again being more positive than the other two. This seems to be related to these teachers' way of implementing the program and their ability to connect the teaching materials with their own teaching style. The teacher of Barnton School in particular had to cope with difficult class circumstances.

All teachers agreed that eight weeks were a too short time to expect much visible results in student behaviour and all plead for splitting up the program in three or four smaller ones throughout the school year. Teachers were of the opinion that

students had come across Web skills they never had practiced or even discussed before. Especially the reading and evaluating skills were new teaching material; searching the Web was discussed in most classes before, as when students had to search for information for a particular class assignment. For the teachers, the reading skills were the most difficult to discuss with the students because of many students' general dislike of reading on the Web. Evaluating Web information was less difficult to teach because students could express their own opinions, which they liked a lot.

Implementing the program: the students

The students' motivation to work with the program differed greatly. Overall, students from Calmore School and Acton School were mostly positive about it; they were seldom bored and never expressed a general dislike. However, they were critical of some parts, especially lessons in which they had to read a lot, either in their workbook or on the Web. They also found some exercises difficult and sometimes too long. Especially the Acton School students had to work hard during the lessons, but for them they also meant a welcome change from the daily class routine. They worked very well together, and stayed focused throughout the lessons.

Some of the Barnton and Dunham School students were more critical or even negative about the program. Especially at Dunham School, students repeatedly said they were bored with the program and expressed a dislike of the teacher's way of giving instruction and discussing the exercises afterwards. In this class, the program's goals were not discussed with the students, resulting in students not knowing why they were doing so much trouble. This was also reflected in some students' opinion that there was nothing they could learn from the program because "when you grow up with computers at home, you already know everything". This resulted in a quite indifferent attitude. The students of Barnton School suffered from the animosity between some groups of students, which caused much agitation and prevented students from working with concentration. The program was less important for these students than the class atmosphere and its consequences.

Students from Calmore and Acton School were mostly positive about what they had learned from the program. The Acton School students mentioned primarily that they had learned better Web searching skills; Calmore School students also mentioned the fact that they were now more critical of websites and Web information and expressed the importance of reading strategies as using menus to discover the content of a website.

Students' learning results: questionnaires

An indication of the students' changed knowledge of and opinion on the Web are students' answers on a half-open questionnaire item, in which students had to state their opinion on the question "Do you think there is a difference between

information found in books and information found on the Web, and why?" Students could choose between the alternatives 'No, there is no difference', 'Yes, there is a difference', and 'I don't know'. When comparing students' answers before and after the program, there is a significant change in their answers (Chi-square-test, for all students taken together as well as for the separate classes, $p < 0.05$). After the program, more students state that there is difference between the Internet and books (52%, vs. 25% before the program) and the 'don't know' category has diminished (34% vs. 69% before the program). Also important are their answers on the question why they thought there was a difference. These answers showed a clear tendency towards critical statements like "books are more true", "everyone can write anything on the Web", etc. This may be an indication of their changed knowledge of the Web.

The questionnaires' knowledge items focused on students' knowledge of healthy food and critical Web skills. Table 3 gives an overview of students' mean scores for the four classes separately.

TABLE 3: OVERVIEW OF STUDENTS' LEARNING RESULTS (QUESTIONNAIRES)

	Acton School N = 14		Barnton School N = 13		Calmore School N = 26		Dunham School N = 23	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Food items (N items = 10)								
before	5.86	1.29	6.38	1.39	7.46	1.63	6.17	1.85
after	6.93	1.43	7.23	1.30	8.04	1.28	7.83	1.61
Web skills items (N items = 15)								
before	10.36	2.24	9.85	2.73	11.35	2.62	10.96	3.07
after	11.93	2.40	11.00	2.04	12.62	2.25	12.52	1.97

With regard to knowledge of healthy food, all classes show improvement after the program. Both Acton and Dunham School's students' mean scores are significantly higher after the program ((Acton School: $t = -3.51$; Dunham School: $t = -5.00$; $p < 0.05$). The Barnton School results show no significant improvement. Although the program has been carried out very well at Calmore School, these students' mean scores on healthy food items show little progress. This may be due to their relatively high mean scores before the program, compared with the other three classes. The program's way of discussing this subject may have been little challenging for them.

The analysis of students' answers on the Web skills items shows that all classes' mean scores are higher after the program, the Calmore and Dunham School's improvement being statistically significant (Calmore School: $t = -2.20$; Dunham School: $t = -2.38$; $p < 0.05$). Contrary to our expectations when analysing the

implementation of the program in these classes, the different ways in which the program has been carried out in these classes are not reflected in the students' results on the questionnaires.

Students' learning results: final assignments

Three student pairs of each class of mixed gender and achievement level performed the six final assignments. The assignments focused on students' actual Web use.

Appendix 1 presents the total amount of Web searching, reading and evaluating strategies students used in the assignments 1 and 2, in which students had to search the Web to find a specific answer. Average time spent at assignment 1 was 6.2 minutes; average time spent at assignment 2 was 8.5 minutes. Because students were free to use the Web as they wanted, these assignments provide information on what strategies they actually use. We used a strict distinction between searching and reading strategies and restricted the latter to the actual reading of texts on websites. Appendix 1 shows that students mainly used Google when searching for information. They used no other search engines and only in some instances used a directory page or a specific URL. In fact, 'searching' meant for all students in most instances 'searching with Google'. In the lessons, they had discussed and practised the possibilities and limitations of using Google as well as other searching strategies. This did not influence their actual search behaviour, which may reflect the way they use the Web at home. Although students mostly used single or multiple search terms, they sometimes typed in the whole assignment or used spoken language. While reading Web texts, students mostly used scanning strategies and only sometimes used the menu or links on a website. This is reflected in the figures in the 'non-reading' category: students often came across a relevant menu or link but failed to recognize it. 'Non-reading' also often occurred while scanning Web texts, especially in the from of ignoring of relevant headings. With regard to Web evaluating skills, students never questioned the reliability of a specific website. They sometimes explicitly paid attention to the usefulness of a website, but only in terms of the relevance of the information (which was their first concern when trying to find an answer).

To get more insight into the quality of students' Web activities, their performances on the assignments 1, 2 and 3 were studied in greater detail. Table 4 shows the scores of the student pairs of the four classes on these assignments (see also Appendix 2).

TABLE 4: OVERVIE OF STUDENTS PAIRS' LEARNING RESULTS (FINAL ASSIGNMENTS)

	Student pair	Reading level [16]	Score assignment 1	Score assignment 2	Score assignment 3
Acton School	AS1 (2 boys)	C/D	.53	.45	.64
	AS2 (2 boys)	B/C	.75	.70	.75
	AS3 (2 girls)	C/D	.34	.23	.54
Barnton School	BS1 (2 boys)	A/C	.94	.50	.77
	BS2 (2 boys)	C/C	.61	.69	.67
	BS3 (2 girls)	C/not available	.60	.69	.54
Calmore School	CS1 (1 boy, 1 girl)	A/B	.60	.75	.94
	CS2 (2 boys)	A/D	.58	.78	.81
	CS3 (1 boy, 1 girl)	B/C	.54	.31	.81
Dunham School	DS1 (2 girls)	B/C	.69	.43	.78
	DS2 (2 boys)	A/D	.67	.72	.63
	DS3 (2 girls)	A/D	.70	.41	.70

These scores show a very mixed picture of students' performances varying between student pairs as well as between assignments and therefore need elaboration with regard to the differences and similarities in students' Web behaviour. Because of the variation in student pairs between the four classes (for example, the Acton School students' general reading level is lower than in the other classes), the classes mean scores can not be attributed to the classroom context. Therefore, we will look at tendencies on the level of the student pairs, taking the class context into account when necessary.

Most students seemed to act rather impulsively and often began with 'trying out' something, sometimes only to look if something showed up. Patience seemed to be a major characteristic of the better performing student pairs, who combined this with the ability to use the appropriate searching and reading strategies in a flexible way. Students who expected quick results from their searching were easily frustrated. Reading Web texts in particular asks for patience that many students lacked. They tended to overlook certain useful information, e.g., the heading of a website that could tell them that although it concerned the language spoken in a particular country, its main subject was Costa Rica and not Madagascar.

Although the low scores of some student pairs (for example, AS3) reflect their low reading skills, there is no unequivocal relation between reading skills and performance. Student pair CS1 who has the highest reading score combination of all pairs, did carry out assignment 1 not very well compared with the other pairs. On the other hand, their scores on assignment 2 and 3 are high. This suggests that also

[16] On the basis of the scores on the CITO reading comprehension test, students are classified in one of five categories A, B, C, D or E; A representing the highest and E representing the lowest achieving students.

other aspects at both task and student level may influence students' performances. Firstly, the variation between one student pair's scores on the three assignments may indicate that characteristics as reading comprehension level and knowledge of Web skills, do not influence the student pair's performance in a consistent way. Pairs of roughly the same reading level (e.g., CS3, AS2 and DS1) performed rather differently on the assignments. Also, although in general, the weakest readers showed less adequate Web behaviour than the strongest readers, they also seem to have had bright moments or simply some luck which contributed to their scores. Vice versa, the stronger readers sometimes showed a tendency to try certain irrelevant strategies 'just for fun', to see what it would bring about. For example, they would fill in the question they had to answer in Google's search box, although they knew very well that such strategy is not always very useful.

When looking at the various ways students worked with the assignments, we saw that the weaker performing students either tended to stay at one strategy they thought useful, or to try several strategies without really exploring them, in both instances without reflecting on a strategy's relevance and adapting it when it proved to be unsuccessful. Although the stronger performing pairs reflected more on their search behaviour, some of them also could be rather inflexible Web users. Sometimes they were so much convinced of their own capabilities that they stayed at a certain strategy, arguing 'I know it must be here' or 'I always do it like this and it always works'. Table 4 also reveals that several pairs show substantial variation between the scores on the three assignments. Apparently, many students were able to use sophisticated searching and reading skills at certain moments during the assignments, but did not do so consistently. As a result, many student pairs showed more or less unpredictable Web behaviour.

Assignment 3 focused more exclusively on reading skills and strategies. The students did not have to search on the Web, but knew already that the required answer could be found on the provided website. Although most pairs' scores on this assignment are higher than on the other two, there also are exceptions, for example, the pairs BS3 and DS2.

The assignments 4, 5 and 6 focused on various aspects of Web evaluating skills. In assignment 4, students had to give some positive and negative comment on a particular website on animal protection. The lessons had paid attention to several aspects of evaluating Web information (such as assessing a website's author and intentions and assessing its reliability and relevance) and had emphasized the necessity to navigate thoroughly through a website to be able to give an opinion on those aspects. In this assignment, we wanted to know which elements of a website

students mentioned spontaneously and how they got to their opinions. Table 5 shows the aspects students mentioned.

TABLE 5: ASPECTS MENTIONED BY STUDENTS IN ASSIGNMENT 4

Aspects students mention	N pairs mentioning that aspect
1. Appearance	12
2. Quantity of information/text	7
3. Quality of information/text	6
4. Amount of links on homepage	4
5. Relation between homepage and purpose of the site	5
6. 'Fun' elements	3
7. Usefulness for children	2
8. Information is easy to find	2

The website's appearance was an aspect all students mentioned, either positively ("the pictures are nice") or negatively ("I don't like the background colour"). Seven pairs mentioned the aspect of information in their comment, either in a quantitative sense ("they give much information") or in a qualitative sense ("the information is clear"). Only two student pairs navigated deeply into the website. They connected several pieces of information the website provided with each other, and commented on aspects as the appropriateness of certain pictures or the relation between the website's mission and its pictures and text.. The others either stayed at the site's homepage, or navigated without reading content or looking at the meaning of the site's illustrations.

In assignment 5, students had to formulate the intentions of a specific website on Dutch wetland areas. Such 'why' question was one of the prominent elements of the program's lessons on evaluating Web information. The teachers had discussed several websites' intentions with the students and students had practised this during computer time. In the lessons, intentions were described as 'providing information', 'giving an opinion on something', 'advertising' (either commercial or non-commercial), 'fundraising', 'entertaining' etc. Students were told to look for more than one intention, as many websites show in fact a combination of intentions. Table 6 shows the intentions the student pairs mentioned.

TABLE 6: LABELS MENTIONED BY STUDENTS IN ASSIGNMENT 5

Labels students mention	N pairs mentioning that label
1. 'Advertising' (fundraising, publicity, canvassing) ("they want you to become a member", "they want you to donate money", they want to raise money", etc)	10
2. 'Information' ("they want to give information about the wetlands", "they want people to know more about the wetlands", etc)	5
3. 'Opinion' ("they want to show how beautiful the wetlands are", "they want to let people know that the wetlands are threatened", etc)	5
4. Trivial ("they want people to be less lazy")	2

Almost all pairs mentioned one or more of the labels they had learned during the lessons (e.g., 'information', 'advertising') and they also often mentioned more than one label. Two pairs connected two labels with each other (e.g., "they want to raise money / they want you to become a member so they can protect the wetlands better"). Many students did not infer their labels from a thorough investigation of the website's content. Students clicked on the menu and on links, without really knowing what to do or without reading. This was reflected in the fact that they gave the label 'advertising' very often and easily, without being able to say what the website was advertising about.

The last assignment on evaluating skills asked students to determine the usefulness of a particular website for children. Determining the usefulness of a website was one important element of the lessons on evaluating Web information. Although the website (on safe Internet use) mostly contained information for parents and teachers on risky aspects of children's Web use, the website's appearance was very childlike, due to its colours, fonts etc. Four of the six pairs that made this assignment argued the website was mostly for parents or not useful for children. Their arguments were based on the type of links (like 'Parents', 'Teachers' and 'Press') or on the 'boring information' on the website. The two pairs that thought the website to be useful for children, based their opinion on the presence of a link for children and on the site's appearance. One pair spontaneously asked themselves what the website was about and used arguments as "the language is too difficult for children" and "the information is written for parents". The others did not think about the website's intentions or purpose. As a result, they did not take such aspects into account and based their opinion on rather superficial elements.

4_ Conclusions and Discussion

Our research aimed at studying the possibility of combining the acquisition of Web literacy skills and of content knowledge, by embedding these skills in an educational program on healthy food. Through a multiple case study design, we wanted to gain insight into both the possibilities and limitations of teaching students critical Web skills in such context.

We can draw some conclusions with regard to the 'workability' of the program we designed and evaluated. In general, the teachers were able to work with the program well. The teaching materials were found very useful and of great importance, especially because the teachers were unfamiliar with teaching Web literacy skills. All teachers regarded the subject of the program (healthy food) as being very useful for their students. Two of the four teachers were explicitly enthusiastic about the program and found it useful for themselves as well as for their

students. The two other teachers had some reserve because they either had not worked with the program in the way they had wanted, or found it too long and difficult to implement.

Our program also showed certain limitations. Some lessons were too long to be finished in the estimated time, which was a problem in classes with limited computer time. The searching skills in particular were dealt with in only one lesson, which made this lesson very dense. Especially for students with less reading skills, the exercises and information in the workbooks were difficult and time consuming. Apart from specific reading problems, the workbook exercises implied a lot of reading, which many students disliked. The lessons on evaluating skills were preferred by both teachers and students. The teachers liked the discussions and exercises; the students came across a new way of looking at Web information, which made quite an impression on many of them. They liked to express to own opinions on the quality and reliability of websites. These lessons also paid less attention to acquiring rather strict formulated skills, as was the case with the lessons on searching and reading skills (which some students did not consider necessary in themselves).

All teachers suggested splitting up the program in three or four smaller projects during a school year. In such way, the searching, reading and evaluating skills could be the focus of a small project on a particular topic. At the end of the year, students should get the opportunity to practice the acquired skills in a project of their own choice. Although a valuable and also practical suggestion, this again points at some tension between the program's goals and their practicability. We aimed at teaching skills and practising and applying them within one program, in order to realize a connection between Web skills and the context in which these skills may be applied.

Teachers worked with the program under different conditions. From the results we derive some contextual factors that influence the realization of the program's objectives. First, teachers must be willing to invest time and effort in the program. Good preparation of both instruction, class discussion and student support (e.g., by making the student exercises in advance themselves) helps teachers in carrying out the lessons successfully. Second, the use of some specific didactical 'tools' seems to be relevant. It proved to be important that the teacher discussed the design and learning goals of the program with the students. Students who knew what the program was about and what was expected from them, tended to be positive about it, whereas other students considered it just some other piece of schoolwork. Talking with students about the subject of a particular lesson and discussing for example their own ways of using the Web or their own opinions on the reliability of Web information, helped students to stay connected with the program and its learning

goals. This seems self-evident, but in fact requires specific teaching skills, which may be difficult for teachers whose focus is primarily on transferring knowledge or supporting students. Also the teacher's use of technical tools as a computer projector proves to be useful: it focuses students' attention, promotes class discussion and makes it possible for the teacher to model certain Web behaviour. Third, certain conditions on the class and school level may be relevant. Elements of the class atmosphere as students getting on well together or the presence of animosity between students affect all teaching, but are even more relevant when students are expected to work together and to discuss freely their opinions on certain subjects. Of more practical concern is the way computer work and its supervision are organised in the school. One teacher cannot support all students working together at the computer; however, splitting up the class makes class assistance necessary.

One important factor influencing the realization of the program's objectives, appears to be a teacher's teaching style. The program was designed as a mixture of conventional teaching methods (e.g., all students working in the same pace with the same prescribed exercises) and socio-constructivist elements like collaboration, class discussion about the Web and the skills required to use it for knowledge construction, and much focus on the process of skills acquisition and the integration and practical use of Web skills. Not all teachers were able to connect these socio-constructivist elements in the teaching materials with their own more traditional teaching style, which was reflected in both the teachers' opinion on the program and the students' attitude towards it. This points at the importance of some correspondence between teaching style and program assumptions.

With regard to students' learning results, all classes show knowledge gain with regard to both the subject healthy food and Web skills. However, we are careful with the interpretation of these results because of the low reliability of the tests used and because our study is set up as a multiple case study and thus lacks a control group. Children of the age of our students learn a lot about the Web outside school. Although the results of the final assignments cannot strictly be interpreted in terms of the program's effects, they do show students' actual Web behaviour after the program. With regard to Web searching and reading skills, most students appear to be inconsistent Web users, who do not always act upon their knowledge of these skills. Although generally speaking, a distinction may be made between stronger performing pairs and weaker performing pairs, both groups showed unexpected Web behaviour. Most students also showed little planning behaviour while searching the Web. Patience seemed to be an important characteristic of stronger performing students. With regard to Web evaluating skills, students were able to use and name

aspects of evaluating Web information that had been attended to in the lessons, such as a website's intentions and its usefulness for children. However, most students did not derive their opinions from a thorough investigation of a website's content and did not navigate deeply into websites.

The students who participated in our research differed in certain aspects. Especially for the Acton School students the teaching materials proved to be difficult because of their reading problems and their not being used to discussing their own opinions. This points to the importance of staying aware in both educational practice and research of an emerging 'digital divide' in terms of literacy skills. Although the Web consists of both textual and non-textual elements, it still is a very textual information resource. It appeals to complex reading skills because of its use of hypertext, which not only allows the user to compose his or her own path through the information it offers, but also makes Web information less clearly structured. Coiro (2003) points out that the Web can be a huge hurdle for weaker readers who deserve specific attention. Aspects as the non-linear character of the Web and its 'information overload' are important elements of that hurdle, as is recognized by many researchers (e.g., Rouet, 2003; Pritchard & Cartwright, 2004; Sutherland-Smith, 2002). Our program would have profited from specific support for weaker readers, especially as the materials themselves also required a lot of reading.

In spite of all the difficulties they came across, the Acton School students stayed very motivated and enthusiastic throughout the program. Compared with many other students, they seemed to look at the Web as an educational tool, something that could help them to learn, instead of seeing the Web primarily as belonging to their leisure time. Although mere speculation, this might reflect their teacher's general emphasis on school work and diligence as being essential for their success in society.

Our results raise some concern about the possibility of teaching Web skills and subject matter in an integrated way. Teaching content knowledge and Web literacy skills together may be possible, but requires some preconditions. Practical teaching conditions like lack of time, computers, room, and student assistance, may be serious obstacles for success. Splitting up the program into smaller parts that contain only one aspect of Web literacy, could give in to the teachers' problems and objections. However, we think Web literacy is more than the sum of its parts and therefore should not be separated in sets of sub skills. The three categories of Web literacy skills – Web searching, Web reading and Web evaluating skills – overlap and are mutually connected. The use of the Web always involves all skills; for example, searching for Web information always involves reading and evaluating skills. Our students' learning results also show the importance of being able to use Web literacy

skills in a flexible way. Many students lacked such flexibility. In our view, this points at the relevance of integrating the various Web skills and of treating Web literacy as a concept that must be taught as well as learned as a whole.

We suggest developing curricula that focus on embedding the teaching and learning of Web literacy skills within inquiry activities. In such way, the connection between Web literacy skills and their actual use for a meaningful goal is more easily made. In our program, this was not the case since only the last three lessons focused on the use of Web literacy skills; in the other lessons the attention was on acquiring the necessary Web skills.

In our view, there must be more research attention on meta-cognitive skills such as planning, monitoring and reflecting that play a role when using the Web for knowledge construction, especially with regard to younger students who do use the Web a lot for homework and papers, but who often still lack the necessary meta-cognitive skills. Our results show students' tendency to use the Web rather inconsistently and suggest some discrepancy between students' knowledge of Web searching, reading and evaluating strategies and their actual search behaviour. This may be connected with the fact that most students use the Web more intensively at home than at school. As a result, the way they use the Web at school may reflect their use at home, where methods like randomly surfing and 'trial and error' probably are much used. At school, students are requested to use the Web for knowledge construction. This requires a more conscious use of the Web and more attention on general inquiry or meta-cognitive skills like planning, monitoring and reflecting skills.

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Appendix 1: Strategies used by students during assignments 1 and 2

	Assignment 1	Assignment 2	Total
Web searching strategies			
1. Google - one search term	13	5	18
2. Google - multiple search terms	14	24	38
3. Google - whole question as search term	1	5	6
4. Google - spoken language	2	7	9
5. Other search engine			
6. Specific URL	2	1	3
7. Directory page	5	2	7
8. Children's search engine		1	1
9. Search option within a specific website		4	4
Total	*37*	*49*	*86*
Web reading strategies			
1. Reading text on a website literally	3	6	9
2. Scanning text on a website (using keywords, headings)	17	12	29
3. Using the menu on a website	5	3	8
4. Using links on a website	5	2	7
5. 'Non reading': Scrolling through Web texts or clicking websites away, without reading or using relevant keywords/clues	13	19	32
Total	*43*	*41*	*84*
Web evaluating strategies			
1. Deducing a website's reliability from its URL			
2. Deducing reliability from a website's visual elements / appearance			
3. Deducing reliability from the quantity of information			
4. Deducing reliability from the quality of information			
5. Determining usefulness of a website on the basis of understanding of the information	2		2
6. Determining usefulness on the basis of reliability / trustworthiness			
7. Determining usefulness on the basis of relevance of the information	9	7	16
Total	*10*	*7*	*17*

N student pairs = 12; counted are all instances a specific strategy occurred; one student pair could use a number of (the same or different) strategies during a specific assignment. Evaluating strategies are deduced from explicit remarks made about the reliability or usefulness of a specific website.

Appendix 2: Summarized coding form used for the analysis of assignments 1, 2 and 3

The form is used in order to assess the adequacy of students' searching and reading activities within the context of that specific assignment.
An activity is seen as a distinct action on the screen. Talking about an activity is not counted as an activity unless talking leads to action. Activities may concern three aspects of students' Web behaviour:

- T = typing a word or a couple of words
- C = clicking on a search result or a link, menu or option
- R = reading activity; reading may refer to reading a specific Web text as well as reading a list of search results. Assessing a reading activity takes both the students' screen behaviour and their conversation into account.

All activities receive the score 0, 0.5 or 1, depending on the adequacy (or relevance) of that activity in the context of a specific assignment.

- 0 The activity is irrelevant for completing the assignment and does not contribute to finding the right answer; this category also contains 'non-actions' such as skipping a relevant text on a website in which the answer may be found
- 0.5 The activity is somewhat relevant for completing the assignment, it might contribute to finding the right answer.
- 1 The activity is relevant for completing the assignment, it does contribute to finding the right answer

Examples (of coding for assignment 1: "Which language is spoken by inhabitants of the island Madagascar?")

T 0 Typing 'language' in Google's search box
T 0.5 Typing 'Madagascar' in Google's search box
T 1 Typing 'language Madagascar' in Google's search box

C 0 Clicking on a search result that has no reference to Madagascar in its heading or accompanying text
C 0.5 Clicking on a search result that has some reference to Madagascar in either heading or text, but has no reference to language spoken on Madagascar
C 1 Clicking on a search result that refers to both Madagascar and language spoken on Madagascar in heading or text

R 0 Scrolling on or reading a particular Web text that contains the answer on the question, but failing to see that answer (e.g., because students read too fast); looking for the answer on a website that does not refer to Madagascar
R 0.5 Scrolling on a particular website with the question in mind, but absent-mindedly, which may be reflected in students' actions and talking (e.g., "we must look for headings about the language they speak" while scrolling too fast to really read anything)
R 1 Scrolling on a relevant website or reading a relevant Web text clearly with the question in mind, which may be reflected in the way students talk while reading (e.g., "we must look for a heading about the language they speak")

Chapter 3

Developing Web literacy in collaborative inquiry activities[17]

Although many children are technically skilled in using the Web, their competences to use it in a critical and meaningful way are usually less well developed. In this article we report on a multiple case study focusing on the possibilities and limitations of collaborative inquiry activities as an appropriate context to acquire Web literacy skills in primary education. Four 5th grade school teachers and their students worked with collaborative inquiry activities on the subject of 'healthy food'. The project was aimed at both the development of Web literacy skills and content knowledge building. Data from a variety of sources were collected: videotaped and written lesson observations, interviews with teachers and students, teacher diaries, student questionnaires, and student assignments. The teachers appeared to be able to carry out the program to varying degrees. Contextual factors that influenced the realization of the project's goals and results were the adequacy of the research questions formulated by students, students' inquiry skills, and the teachers' teaching styles. Students' learning results show that it is possible to teach Web literacy skills in the context of collaborative inquiry activities. All classes show knowledge gain with regard to the subject healthy food and all classes but one show knowledge gain with regard to Web literacy skills. Although many students show adequate use of particular Web searching, reading and evaluating skills after the project, inconsistency, impulsiveness and impatience are also typical of their Web behaviour. In the context of collaborative inquiry activities teachers are challenged to deal with the paradox that they want their students to be active knowledge builders with help of the Web, whereas the Web seems to invite students to be more or less passive searchers.

[17] Kuiper, E., Volman, M. & Terwel, J. (2006). Developing Web literacy in collaborative inquiry activities. Manuscript submitted for publication.

1_ Introduction

Children growing up in current Western societies probably cannot imagine life without the Internet. Most children have the Internet at their disposal either at school or at home or at other out-of-school locations such as libraries. The Web, in particular, is almost omnipresent in their lives, and children seem to use it quite naturally for gaming, for instant messaging and downloading their favourite music. They also become Web authors themselves by constructing their own websites. Children often perceive the Web as a user-friendly resource because it contains a great deal of information as well as pictures that can be downloaded and relocated for their own purposes. At school, many students use the Web as an information resource.

The Web certainly has considerable potential as a supplement to the information resources traditionally used in the classroom. However, it has not been designed for use by children, nor for use in educational settings. Problems with the validity, thoroughness and meaning of knowledge acquired through the Web have been pointed out from the outset (e.g., the 'butterfly defect', Salomon, 1998). The Web as an information resource can only play an adequate role in students' learning under certain conditions (Kuiper, Volman & Terwel, 2005). Research shows that, although children may be confident Web users, they often do not have sufficient Web skills at their disposal. Most children lack adequate Web searching skills, as well as skills to process and critically evaluate Web information (Schacter, Chung, & Dorr, 1998; Fidel et al., 1999; Lorenzen, 2001; Shenton & Dixon, 2003; Pritchard & Cartwright, 2004). As a result searching for information usually leads to insufficient knowledge and understanding. Moreover, studies that focus on older aged (college) students' Web behaviour also show a lack of critical Web skills (e.g., Metzger, Flanagin & Zwarun, 2003). Several authors have observed that the use of the Web requires the development of new literacies (e.g., Snyder, 2002) as well as Web literacy curricula (Metzger et al., 2003). Pleas have been made for future research that focuses on the design of learning environments that incorporate the use of the Web into inquiry activities in which Web literacy skills such as searching for, reading and evaluating information are not ends in themselves but means to answering queries (e.g., Frechette, 2002).

In this article we present an evaluation of a program in which we collaborated with four 5th grade teachers (students aged 10-11 years) in order to translate these recommendations into school practices. We developed the outlines of a 10-weeks inquiry unit for students in which the acquisition of Web literacy skills is targeted in the context of collaborative inquiry activities on the subject 'healthy food'. In our analysis we focus both on the ways teachers and students worked with the program,

as well as on the results of the program in terms of content knowledge and Web literacy skills. By looking closely at the different contexts in which the program was implemented, we wanted to gain insight into the contextual factors that influence the realization of such a program.

2_ Theoretical framework

2.1 Theoretical perspectives

Conditions for the use of the Web as a source of information in educational contexts have been the subject of research in various, mostly unconnected, bodies of literature, under different theoretical perspectives.

Scholars in critical pedagogy and reading theorists have analysed the Web as a new social tool or new type of text with specific characteristics, requiring new knowledge, skills and attitudes from its users (e.g., Burbules & Callister, 2000; Frechette, 2002; Coiro, 2003; Snyder, 1998; Leu, Kinzer, Coiro, & Cammack, 2004). The size and topicality of the Web implies that students must have good searching skills in order to find what they are looking for. They also must be capable of making decisions on their own information needs. The Web's accessibility implies that children have to become aware of its downsides and learn to cope with such negative aspects. The use of hypertext makes high demands on critical reading skills. Children have to learn to ask themselves constantly why they are reading a Web text. Assessing the reliability of Web texts plays an important part in this process. Finally, the visual character of the Web makes it necessary for students to learn to 'read' such visual information and to learn to judge the visual information on functionality and meaning, and how it relates to the text. All these points highlight the importance of 'new literacies' that include " […] the skills, strategies, and dispositions necessary to successfully use and adapt to the rapidly changing information and communication technologies and contexts that continuously emerge in our world […]" (Leu et al., 2004, 1572).

Researchers in the field of Library and Information Science (LIS) have studied the Web as a new source of information, in addition to printed information. This type of empirical research studies the characteristics of children's Web search behaviour: how do they search for information on the Web, what problems do they encounter and what are the results of their searches (e.g., Bilal, 2000; Fidel et al., 1999; Shenton & Dixon, 2003). The results of these studies show a picture of children as technically skilled, but rather naïve Web users. Most children lack sufficient search skills as well as skills in the effective use of the information they find. Moreover, children rarely look at the reliability and authority of the information

they find. They either do not wonder about the Web's authority, or do not know how to evaluate the Web on this point. In terms of this information oriented discipline, all this points to the importance of information literacy skills: the ability to recognize when information is needed and the ability to locate, evaluate and use the needed information effectively (American Library Association, 1989).

Finally, educational researchers have explored the use of the Web as a new type of learning tool. They are primarily interested in how information retrieved through Web search processes can contribute to the construction of knowledge. Most of the research is concentrated on the science domain and attempts to incorporate the use of the Web information into students' inquiry activities (e.g., Wallace, Kupperman, Krajcik & Soloway, 2000; Jones, 2002). The Web offers a valuable supplement to the resources traditionally used in science education, offering primary, current and interactive material that cannot be found in any textbook. However, almost ten years ago, Soloway and Wallace (1997) already pointed at the limitations of the use of the Web in science education. They stated that "[…] given the current tools, organization, and content on the web, […] searching the web may well not be an educationally productive activity" (p.11). They question the usability of the Web for inquiry activities: the Web invites students to search, which differs from the activity of *re*search, which asks for repeated searching, and for the construction and synthesis of the information found. Most of the ensuing educational research on Web use has tried to solve this problem by simplifying the use of the Web for students, for example by supporting them with an interface that offers some solutions for their lack of search skills (e.g., Wallace et al., 2000; Hoffman, Wu, Krajcik & Soloway, 2003). This is also noticeable in the many 'good practices' found on the Web that offer teachers selections of websites on a certain domain or subject. Students can focus their attention on pre-selected websites with useful information and do not have to spend time on endless Web searches.

This solution is understandable when one uses the Web primarily for offering information that can contribute to the construction of knowledge in a certain subject domain. However, such a solution is neither conducive to, nor appropriate to foster students' independent and critical use of the Web (Burbules & Callister, 2000). In this respect Frechette (2002) mentions the importance of empowerment: by teaching students to deal critically with the from and content of the Web, they will have a greater say in their own knowledge construction. In light of this, we would advocate an approach whereby the Web is not only seen as a tool in education, but also as a tool that students must learn to master. In other words, the ability to handle the Web critically should be an explicit educational goal. We will refer to such an ability as 'Web literacy'.

2.2 Components of Web literacy

Web literacy may be seen as an umbrella term that comprises a combination of various skills regarding the critical use of the Web for one's own purposes. Reading researchers and the above-mentioned LIS researchers, in particular, have worked out the principal components of Web literacy (e.g., Coiro, 2003; Sutherland-Smith, 2002; Burke, 2002; Enochsson, 2005). In our view, three principal subcategories of skills can be distinguished: Web searching skills, Web reading skills and Web evaluating skills. Searching skills, for example, include the ability to define appropriate key words and locate relevant information as well as knowledge of the different ways to locate Web information, and their possibilities and limitations. Reading skills can be understood as the ability to use the results of search engines like Google; handling all elements of hypertext, e.g. the function of Web page links; assimilating great amounts of diverse information; and knowing what information to use and explore and what to ignore. Evaluating and processing skills denote the ability to assess the reliability and authority of Web information; knowing how to relate text and images on Web pages; and using Web information for one's own information need. Although for purposes of research it may both be valuable and necessary to distinguish between such categories of sub skills, we wish to emphasise that Web literacy is not simply a sum of its parts and that it cannot be reduced to sub skills. Also, it is impossible for the three categories to be strictly separated; rather, they overlap and are mutually connected. For example, good searching skills invariably involve some reading and evaluating skills. Moreover, use of the Web implies that searching, reading and evaluating are interwoven and constantly go together. In fact, the conclusion is warranted that the Web demands flexible use of these skills in particular.

In our design of a curriculum for acquiring Web literacy, we started from a socio-cultural approach. According to socio-cultural theories of learning, learning is enhanced by students' participation in 'real world' activities that are meaningful and challenging to them (Lave & Wenger, 1991). On the Web, students can easily and independently investigate questions. From this perspective, actual use of the Web is also a meaningful way for acquiring Web literacy. It confronts students with the problems involved, such as the abundance of information and the temptation of endless browsing through hypertexts. However, for learning to take place, reflection on the problems involved in Web use and support in dealing with these problems are also necessary. It is precisely reflection that education can add over and above participation in real-life social practices (Ten Dam, Volman & Wardekker, 2004). In learning environments, designed from a socio-cultural perspective, this combination of participation and reflection is often organised in communities of inquiry (Wells,

2000). Such communities are engaged in collaborative group work, inquiry activities based on students' own research questions and knowledge building through dialogue between teachers and students. We believe this to be a promising approach to making the development of critical attitudes toward Web information into a meaningful curricular goal. This perspective fits in well with pleas by reading researchers and scholars in critical pedagogy to embed Web literacy skills in inquiry activities (e.g., Frechette, 2002). Although many Web-based 'good practices' exist which focus on either the acquisition of Web skills or inquiry activities, there is hardly any empirical research that focuses explicitly on the acquisition of Web skills within inquiry activities, especially with regard to the primary school ages.

Therefore, in this study, we have taken a first step towards putting this approach into practice. We designed, tried out and evaluated a program/project in which the acquisition of Web literacy skills was embedded in the context of collaborative inquiry activities on the subject of healthy food. Our overall goal was to gain insight into the possibilities and limitations of collaborative inquiry activities as an appropriate context in which to acquire Web literacy skills. Our research, being explorative in nature, was guided by the following research questions:

a. How do the teachers and students give shape to the program and how do contextual factors influence the realization of the program?

b. What are the learning results of the program in the participating classes in terms of both content knowledge and Web literacy skills?

3_ Methods

3.1 Participants and Setting

Four 5th grade teachers (three male, one female) and in total 93 students from four different schools participated (51 male, 42 female; mean age 10.6 years). The four participating classes differed in aspects as class size, teacher experience, and the students' socio-economic background and their reading ability. All schools had good ict facilities and both teachers and students were used to work with the Web as well as with other ict-applications. The four participating teachers were familiar with working with collaborative inquiry activities and with incorporating the Web into these inquiries. They were all convinced of the necessity of teaching students Web searching, reading and evaluating skills. Although most of their students were used to use the Web both at home and at school for inquiry activities like class projects and individual papers, the teachers shared the opinion that they did not have enough Web skills at their disposal. All teachers questioned the knowledge and insight

students acquired through using the Web as an information resource, although they were able to produce good-looking and often quite impressive papers which contained a lot of information.

With regard to the participating classes, there were no significant differences between the classes with respect to Internet connection at home, the time students spent at the computer at home, self-reported Web skills, their preference for either books or the Web as information resource for school assignments, main language spoken at home and the parents' native country.

Kingsley School[18] is situated in a newly built suburb of a big city. Its student population is mostly from a white, upper middle class background. Since its foundation, the school practices socio-cultural views on education. In the upper grades, project work and inquiry activities of all sorts are very common for both teachers and students. In the school's policy, ICT plays a significant part: the computer facilities are excellent and the school has a full-time ICT coordinator who assists teachers in the technical and didactical aspects of the use of ICT in their teaching. At the time of the study, Thomas, the teacher, has had four years of teaching experience. He is relatively inexperienced in the technical aspects of ICT and in using technical devices such as computer projectors. The class had 26 students (10 girls and 16 boys). The students' average reading comprehension score is 51.8 which is above the national average of 49.0.[19] There is, however, much variation between students.

Langdon School is located in an old neighbourhood of a big city. Its student population is mixed, but mostly from a white, middle or upper class background; a minority of the students are from other origins (Surinam, Turkish or Moroccan). The school participates actively in a network of schools, all working according to socio-cultural views on education. The lower grades are used to working in that way; the teachers of the upper grades are still looking for ways to combine project work and inquiry activities with the growing pressure to rely on testing and marking. The school has good ICT facilities which are much used by all teachers. Jim, the teacher of the participating class of 24 students (13 girls, 9 boys), works half-time at the school. He has three years of teaching experience and teaches this class for the second year. The students' test scores on reading comprehension are 57.4 which is far above the national average. In spite of the class' potential, the teacher finds it sometimes difficult to motivate the students and to accomplish a good class climate.

[18] Names of schools and people have been changed to ensure anonymity.

[19] Derived from a standardised Dutch National School Achievement Test (from the CITO, the Dutch National Institute for Test Development).

Milford School is situated in a town's suburban area. The student population is mostly from a white, middle class background. Lorna, the teacher, runs the class together with a colleague, both teachers working half time. They are familiar with using collaborative inquiry activities inspired by socio-cultural views on education, although the school does not explicitly share this view. The school has good ict facilities. Lorna is an experienced Web user, and is familiar with technical devices, for example the use of computer projectors. Her class of 27 students (12 girls, 15 boys) was characterised in earlier years as 'difficult to manage'. Both teachers worked hard during the first half of the school year to change this and when the program started in January 2005, they had established a good class climate. The students' average reading comprehension score is 46.6, which is slightly below the national average. The teachers see their students as active (especially the boys), but lacking in reflection; more 'doers' than 'thinkers'.

Norwood School is a small village school. The student population is from a white middle and lower middle class background. The school often works with inquiry activities of all sorts from several educational, including socio-cultural viewpoints. It has good ICT facilities and a school principal who stimulates the use of all sorts of ICT applications in the classes. Teacher Jonathan is a very experienced teacher who has worked for more than 25 years at the school and teaches the participating class for the second year. He likes to work with spontaneous, student-directed activities. His class only contains 18 students (7 girls, 11 boys). Their average reading comprehension score is not known exactly but characterised by the teacher as being 'low to average'; there are several dyslectic students in the class. The teacher has difficulties establishing a good class climate; students are very easily distracted and especially the girls do not get along very well.

3.2 Materials

Design and content of the program

The program comprised 10 weekly lessons of 1,5 to 2 hours each. Based on the literature, we formulated as starting point to guide the from and content of the unit: collaborative, inquiry-oriented activities as a means to, and context for, both content knowledge building and acquisition of Web literacy skills.

Students were asked to collaborate in the production of a brochure about 'healthy food' intended for the other 5th grade classes at school. The subject of the unit was chosen because of its authenticity, since it can easily be connected with children's real life experiences. Children eat every day, and most of them experience some tension between healthy food habits (stimulated by most parents and teachers) and their own food preferences. The program was set up in such a way that the

development of critical Web skills and content knowledge building would evolve in tandem during the lessons. Working in pairs and supported by the teacher, students were required to formulate research questions on the overall theme and on sub themes. These questions had to be appropriate for the acquisition of Web literacy skills, i.e. be rather concrete and factual, making it possible to find relevant information and to practice those skills. The teacher encouraged them not only to search for Web content but also to read and evaluate it critically in order to make it meaningful for themselves and their future readers. Thus, by constantly relating the students' Web activities to the production of the brochure, the teacher tried to make clear the need for those skills. For example, getting endless lists of Web pages from a search engine required students to from their own opinions on the usefulness of those pages for their research questions and for the brochure. During the project, the teachers offered the students tools for and support in both Web literacy skills (searching, reading and evaluating Web information) and inquiry skills (e.g., constructing adequate research questions and processing the information found).

Table 1 shows the overall structure of this inquiry-based program as well as the aspects of Web literacy which were addressed by the program. The first two project lessons were meant to be introductory and consisted of joint activities focusing on collaborative inquiry activities with shared goals. The teacher and the children discussed several aspects of the project subject, for example based on collages of what students thought to be healthy and unhealthy food items. By questioning their opinions, the teacher modelled a critical, inquisitive attitude. Suggested home activities related to the project were for example constructing 'eating diaries', and collecting packages of food items and food advertisements. Based on all these activities, the teacher and students constructed research questions on three sub themes. From the third lesson on, the students used the Web to obtain information for the brochure on the basis of their questions. In these lessons, all three subcategories of Web literacy skills were successively addressed. Most lessons began with a class discussion about the lesson's central topic, e.g. 'What are the differences between reading a book and reading a Web text?' or 'Do you believe all Web information is true?'. These class discussions would give the teacher the opportunity to explore the students' knowledge and opinions on such matters. After the class discussion, computer work alternated with whole class discussion on the students' experiences when using the Web. The last two lessons of the program were intended/meant for the production of the brochure.

The four participating teachers were supported in several ways. They had a manual at their disposal with for each lesson specific learning goals, suggestions for class activities and class discussions, examples of several ways to support student

that particular lesson, and practical guidelines. The teachers also met each other during a training course in the month preceding the project. In this course, the basic assumptions of the project and its learning goals were explained and discussed. The teachers also practiced parts of the project's lessons together. They were explicitly invited to adapt the project to their own students and circumstances, provided that the project's main characteristics (as described above) would be preserved.

TABLE 1: OVERALL STRUCTURE OF THE PROGRAM AND ASPECTS OF WEB LITERACY ADDRESSED IN THE PROGRAM

	Web literacy skills and strategies	Thematic activities
Weeks 1 and 2		Starting up the project Drawing up research questions
Weeks 3 and 4	Web searching skills and strategies: - meaning and proper use of URL's - browsing strategies - formulating key words - navigating through lists of results from search engines - evaluating the relevance of these results - using search strategies in a flexible way	Searching for information on the Web in the context of students' research questions
Weeks 5 and 6	Web reading and interpreting skills and strategies: - various ways in which websites may be structured - practising reading of several types of Web texts - using navigational aids such as toolbars and menus - skimming Web texts to identify key words or phrases - in-depth reading of relevant passages - purposeful use of links in Web texts	Applying reading skills to be able to select useful Web information for the brochure
Weeks 7 and 8	Web assessment and evaluating skills and strategies: - assessing one's own level of understanding of specific Web texts - getting insight into the relative accuracy and reliability of Web information - judging the accuracy and reliability of Web information - relating the information found on one's own question or need for information - assessing the function and meaning of visual website elements	Applying evaluation skills to be able to assess the selected Web information with regard to its comprehensibility, reliability, and usefulness for the brochure
Weeks 9 and 10	Joint application of the Web searching, reading and evaluating skills and strategies, with a view to composing the brochure	Presenting the results of the project: composing the brochure and presenting it to an audience (students, teachers, parents)

3.3 Instruments and Procedures

An in-depth study of the project required the collection of a variety of data both on the experiences of the teachers and on the learning processes of students. For this purpose, lesson observations and face-to-face interviews with teachers were combined with student interviews, student questionnaires and a final student assignment.

Lesson observations, field notes and interviews with teachers

Every other week a whole lesson was videotaped for each class. In this way, every lesson in the lesson plan was videotaped in two different classes. The focus was primarily on the teachers' actions and on the dialogue between teachers and students. All videotapes were transcribed. The same lessons were also observed, using diaries with field notes, and observation checklists focusing on aspects such as student involvement, class climate, and the way the teacher supported the students. The field notes served as initial data analyses, with analytic notes providing material for later observations.

In addition, every other week the teachers were interviewed about the lessons and the students' learning processes. The teachers maintained diaries for all lessons. The interviews and diaries focused on the implementation of the program, especially on ways in which collaborative inquiry activities and Web literacy skills were brought up. Teachers were explicitly invited to share their opinion of the program with the researchers, and to discuss the difficulties they had experienced while working with the lessons. This enabled us to compare research observations with the teacher experiences.

Student questionnaires, interviews with students, and final assignments

From the total of 93 students, 84 students completed questionnaires before and after the project. Part of these questionnaires focused on elements of students' backgrounds and their attitudes towards computers and the Web. Another part consisted of 10 knowledge items on the subject of healthy food and 15 knowledge items on searching, reading and evaluating Web information (all multiple-choice items). On both subjects, no reliable tests to determine differences between students of this age are available. Kuhlemeier and Hemker (2005), when constructing a broad test on Internet skills for high school students, deliberately left out items on evaluating Web information because of the failure to construct reliable and valid test items on such critical Web use. Therefore, we decided to construct a questionnaire that consisted of items on a range of aspects of healthy food and critical Web use, without aiming at constructing a coherent test that could determine differences between students and between times. This is reflected in rather low reliability scores (α =.55 for items on healthy food; α =.64 for items on critical Web use). The items on Web use focused on searching/navigating skills and (to a lesser extent) on evaluating skills. Web reading skills were not explicitly addressed, as a pencil-and-paper questionnaire can not reflect the complexity of Web reading in practice. Some elements of reading on the Web were imitated by offering screenshots of Web pages on which the students had to choose between links (e.g., "On what part do you click

when you want to know the entrance fee of the zoo?"). With regard to healthy food, some items were directly related to declarative knowledge students might have come across during the program (e.g., "What are ingredients?"); others were meant to give an indication of a general way of thinking critically about eating habits (e.g., "What is the best solution when you eat not enough vitamins?").

In each class, three students pairs were selected and more intensively observed, using an observation checklist that focused on aspects of students' involvement, collaboration between students and the way students worked with the teaching materials. These students were also interviewed every other week. In these interviews students were free to discuss their opinions on the lessons, on what they had learned that week and on the teaching materials. We aimed at diversity between the student pairs, choosing students of mixed gender and ability. After the program was finished, these 12 student pairs carried out six final assignments that all focused on the application of critical Web skills. Although Web searching, reading and evaluating skills all play a role in Web activities, in each assignment one or more of these skills were more prominent than others. Three assignments focused primarily on Web searching and reading skills, in the other three assignments Web evaluating skills were focused on (for an extensive description of both background and content of the assignments, see chapter 4 of this thesis).

All students worked in pairs, as they had done during the program. For each assignment, they got a maximum of 10 minutes. All sessions were captured with Camtasia Studio screen recording software, which also recorded the conversations of the student pairs. Due to students' illness, in two schools only two pairs took part in the assignments.

We decided not to include the brochures made by the students as an outcome measure. Given the character of the program, the content of these brochures was not really comparable because they reflected the students' specific research questions. The brochures also were group products of the whole class, and therefore can not be reduced to individual students' learning results.

3.4 Design of the study and data analysis

We used a multiple case study design for our study (Yin, 2002). Data analysis focused first on within-class descriptions of the specific way the program had been carried out in each class. Then, cross-class analysis was performed in order to be able to determine which contextual factors may affect the realization of the program and students' learning.

Analysis of lesson observations, field notes and teacher interviews

Video tapes of the lessons were transcribed and analysed in order to characterise the learning environments in each class. Our focal points were both the way teachers and students gave shape to the collaborative inquiry activities, and the ways in which content knowledge and Web literacy skills were raised within these activities. These focal points firstly included elements that may be considered critical when working with collaborative inquiry activities:

- how did students' research questions origin and develop;
- the relation between students' research questions and the subject and goals of the project;
- the way the teachers supported students in their inquiries.
- how did students collaborate, both in pairs and in the whole class;

Secondly, we considered the ways in which the teachers paid attention to the various Web literacy skills, their embeddedness in the projects goals and activities, as well as the relation between content knowledge and Web skills.

While transcribing the video tapes, and matching the tapes with the written observations, we looked for ways in which these elements emerged in the lessons. Lesson segments were described, highlighting key events, after which each classroom was characterised by identifying what elements were present and the ways in which teachers dealt with those elements. We also looked at the way the teacher worked with the provided teaching materials. Transcriptions were also made of all teacher interviews. These transcripts were analysed with a view both to the elements used for the analysis of the observation data and the teachers' ways of reflecting on their own way of working, on the project as a whole and on the provided teaching materials. The interviews also provided a means of triangulation, by comparing and contrasting them with the observation data.

Analysis of student interviews, observations, questionnaires and final assignments

The transcribed student interviews were analysed with a view to students' opinions on the project and on the way the teacher worked with it. We focused specifically on aspects as students' involvement, their research questions and their success or failure to find relevant information, and their views on the project. Student observation data primarily served triangulation, by comparing them with the interview data.

Students' answers on the knowledge items of the questionnaires were scored, both for the total group of 84 students and for the four classes separately. T-tests were performed to compare the four classes' mean scores before and after the project.

The Camtasia screen and audio recordings of the final assignments of all 12 student pairs were transcribed. These transcripts provided insight into students' ways of working with the Web as well as their collaboration and discussions. First, students' performances were analysed with a view to the Web searching, reading and evaluating strategies the program had paid attention to (see Table 1). To assess the adequacy of students' Web searching and reading strategies in the first three assignments, we designed a coding procedure in which each separate reading and searching activity was first coded and then scored as either 0, 0.5 or 1, depending on its adequacy in the context of that specific task. The reliability of the coding procedure was calculated by coding about 50% of the activities twice, by two independent researchers (Cohen's kappa =.87). These scores were added up and then divided by the total amount of reading and searching activities each pair had conducted in that assignment. In this way, an overall score (laying between 0 and 1) for each student pair's adequacy in using Web searching and reading skills was calculated (see chapter 2 of this thesis for a more detailed description of the coding procedure).

In the three assignments that focused primarily on students' Web evaluating skills, students were asked to discuss the quality, intentions or usefulness of a specific website. To get an overview of all arguments students used as well as their relation with the aspects of evaluating Web information that were discussed in the lessons, the transcripts of the student pairs' dialogue and screen behaviour during the assignments. Jointly, these data provided insight into the Web literacy skills students were able to use, as well as their specific Web search behaviour during the various assignments.

Finally, data from multiple sources (classroom and student observations, students and teacher interviews, students' final assignments) were analysed in relation to each other and between classes.

4_ Results

First, we portray the four classes with regard to the way the teachers and students worked with the project. We focus on the way they gave shape to the collaborative inquiry activities and the acquisition of Web literacy skills, as well as students' opinions and behaviour and general issues as the teachers' appreciation of the project and their comments on the way the project worked out for their specific situation. Then, in a cross-class comparison we will compare classes with a view to the contextual factors that influence the realization of the program as well as students' learning results.

4.1 Within-class description of the four classes

Kingsley School

From the beginning of the project, Kingsley School students showed a great deal of knowledge about the subject healthy food. Because of this, the teacher (Thomas) expected much from students and also placed high standards on the students' research questions. This partly led to students formulating rather broad and open research questions. Although the teacher noticed that several questions were not appropriate for Web searching or knowledge building, because of time pressure he rarely questioned them or discussed them with the students. As a result, part of the students searched the Web with research questions that were either too difficult or too broad, or inappropriate for Web searching, such as for example, "How many healthy things are there?" and "How do vitamins originate ?" In those cases, the type of questions affected both the students' way of working on the Web, and the way Web literacy skills could be addressed. Students easily became frustrated or discouraged when their Web searching did not produce the desired results. Moreover, they were confronted with the difficulties of Web use without being able to practice the Web skills discussed in the project on 'workable' questions.

The students were used to work in pairs and small groups, and did so when working with the Web during the project. Thomas found it difficult to support all student pairs, which was partly due to the location of computers in school hall and several corridors. As a result, some students merely sat together at the computer and did not really work together. In class discussions, the students were not as active as the teacher expected them to be. He frequently became irritated by their lack of involvement but found it difficult to stimulate and activate them. The students' behaviour seemed to reflect their not knowing why they were doing this project. The teacher had explained to them the need to acquire Web literacy skills, but most students already were quite confident about their own Web skills. The project's purpose, the making of a brochure, was mentioned frequently by Thomas, but the students' did not experience their Web activities as connected with making the brochure: "It is always yes in the end there will be a brochure. But when will there be one then?"

Part of the students' comments was a result of the way inquiry and Web activities were commonly regarded in this class. Students were used to use the Web for their own projects, with subjects of their own choice and looked at the Web as something they could use as they wanted. They had expected the project to be like that, which suggests a gap between students' expectations and the project goals and activities. The teacher tried to motivate and stimulate the students in the subsequent weeks, with moderate success. The brochure was drawn up after the project by only

four students. They assembled some of the information they had found during the project, but did not use any information provided by the other students. The brochure is instructive, but shows no connection with the Web activities of the previous weeks. Thomas was rather disappointed in how the project had worked out. Yet, his impression was that the students did learn something during the project, especially with regard to Web skills.

Langdon School

The Langdon School teacher, Jim, was used to working spontaneously, initiated by the students or himself. This was reflected in the way he carried out the project. For example, at the start of the project, Jim decided to explain goals and purpose of the project (i.e., making a brochure for fellow students) not beforehand because he wanted to leave more initiative to the students.Unintentionally, this resulted in students not knowing why they were doing project activities. Jim's teaching style was also reflected in his approach of students' research questions that would guide their Web activities during the project. Instead of negotiating these questions with students, Jim wanted students to discover themselves which questions would 'work' and which would not, hoping they would conclude that they had to adapt their questions.

In doing this, he seemed to overestimate both the students' motivation and their inquiry skills. In practice, many students did not mind surfing the Web with all sort of questions, as long as they could use the Web freely. As a result, the research questions that were supposed to guide their Web activities were often too broad or simply inappropriate for searching the Web, as at Kingsley School. Jim recognized many students' need for support and guidance during computer work, but lacked time and overview to fulfil those needs. After a couple of project weeks, the teacher struggled with the question how to combine the project requirements with his own spontaneous way of working with the class. The students had grown a bit bored and were losing their motivation.

This process was reinforced by the way students worked together. Although the students were used to collaborative group work, they did not rely on each other to complete their tasks, neither in pairs nor in class. There was a general class climate in which students did not really listen to each other during class talk and some students tended to react negatively and childishly to other students' utterances. In the teacher's eyes, his students generally easily lost motivation and 'gave up' because they wanted school to be 'fun'.

Looking back on the project, Jim was not wholly satisfied. The class had not worked in the way he had wanted, and the inquiry activities did not live up to their

promise. He noticed a tension between his own preferred way of teaching and the students' need for structure and guidance when using the Web.

However, the students produced a very nice brochure at the end of the project although only a small part of it was connected to the inquiry activities the students had carried out the weeks before. The quality of the brochure reflected the students' experience with all sorts of writing and editing activities. The brochure was presented very nicely as a school paper for all parents and students. The value of the teacher's strong inclination to spontaneous activities showed itself in one particular part of the brochure about the pros and cons of eating insects. By proposing to cook grasshoppers in school because of their nutritiousness, Jim urged students to have a debate about the ethical aspects of doing this, and to search for information on the Web about grasshoppers' nutritional value and ways of preparing grasshoppers.

Milford School

From the beginning, Milford School teacher Lorna put much time and effort in the project. She followed the teaching guidelines more or less, but adapted these if necessary to her own situation. She was enthusiastic about the project and an active and stimulating teacher, which resulted in students really liking to work with the project. Lorna was able to show students what the project was about without exercising too much control and she recognized possibilities for learning when they showed up.

Drawing up research questions was a collaborative activity in this class and originated in the students' own experiences. For example, when discussing their own eating habits, some students appeared to skip breakfast most days. This resulted in a research question about the need to have breakfast. One girl, being vegetarian, was challenged by the teacher to formulate research questions about what products are necessary to stay healthy when you are vegetarian. Lorna emphasized the connection between the project and the students' daily lives, by questioning her own eating habits. Teacher and students discussed these research questions, the teacher being more or less negotiating in modifying the question if necessary.

The goals of the project (learning Web skills to be able to make a good brochure for fellow students) was the thread that ran through all project lessons. The brochure was presented as necessary for other students who did not share the same knowledge. For most students, the brochure became a serious and meaningful activity.

Lorna focused explicitly on collaborative group work and introduced herself as part of that group. She talked with the students about their ways of working together at the computer and took time to solve problems. She created certain extra conditions to effect this collaboration, for example, by arranging the classroom in a

way that all students knew what students were working with which research questions on which part of the brochure. She also made shared folders on the computer in which all students could post their work, so students knew more or less what fellow students were producing. This was reflected in the way students referred to each others' questions, and their helping each other with Web information they came across. This was especially important because the computers were located in several halls and corridors. The teacher lacked clear overview and had to rely on students helping each other.

Lorna's frequent use of a computer projector contributed to her being able to connect the students' inquiry activities with the Web literacy skills. She took much time and effort discussing the ways in which the students worked on the Web, thereby focusing on the Web skills that were addressed that lesson. The first two lessons, in which searching skills were at the centre, she practised those skills together with the students, taking as a starting point the problems some students had finding information for their research question. All students were invited to think along with each other and to practice possible solutions. In the next lessons that centred around Web reading skills, she also used the projector in her instruction, discussing with the students the differences between reading a book and reading a website, and providing examples. At the end, the project resulted in a nice, instructive brochure that reflected very well the project's activities. All students contributed to the brochure, albeit in different roles. The brochure was presented by the students in the school's other upper grade classes.

On the whole, the project goals were achieved rather well in this class. However, it required a great deal of effort on the part of the teacher. Lorna also struggled with the fact that on the one hand, the project was too short to pay enough attention to the various Web literacy skills, while, on the other hand, it was somewhat too long to keep the students motivated. In the end, she was fairly satisfied with the project and had the impression that students learned quite a lot. She was also pleasantly surprised by the way students cooperated during the project.

Norwood School

From the beginning, some tension was apparent between the Norwood School teacher Jonathan's own preferred teaching methods and the project's rather strict learning goals. Jonathan appeared to be very good at creating conditions for activating students and for learning. At the same time, he also tended to give students much freedom in finding out for themselves what they wanted to do and know. For example, in one of the first lessons the teacher led an interesting class discussion about healthy and unhealthy eating habits. Interestingly, contrary to most children's opinion that drinking beer and wine is very unhealthy, one child's mother

appeared to have suffered of thrombosis and her doctor has advised her to drink a glass of red wine every day. The teacher mentioned this as very interesting and hinted at the opportunities for exploring this further in their research questions. However, because he left everything up to the students after that, nothing happened with it in the next lessons.

The same phenomenon occurred with class discussion subjects such as the wholesomeness of deepfreeze products and the differences between white and wholemeal bread. This resulted in a loss of potentially motivating research questions and in students searching the Web with questions that were partly less connected with their everyday life or interests. However, on the whole students in this class also formulated 'workable' questions that stimulated Web searching.

The class' small size together with the situation of the computers in one room, made it relatively easy to support students in this class. At many moments during the project, the teacher gave valuable feedback on students' Web activities. However, his tendency to let students decide for themselves what they were to do with such feedback proved to be a too open-ended way of teaching in this class. Expecting students to be active and involved, Jonathan seemed to underestimate his own role. Most of his students needed much support and structure and got the impression that what they did exactly did not matter very much. Their Web searching often resulted in fragmented bits and pieces of knowledge without much connection. Students also did not cooperate very well, despite all the teacher's focus on the rules of collaborative work.

For the students, the project was mainly about food; the Web skills did not really become integrated into the project. This was partly due to the fact that the project time was shorter than for the other classes. Because Jonathan experienced the project as being too long and having too much (theoretical) content, he left out some parts of the curriculum. This resulted in some fragmentation; with regard to the Web literacy skills, most skills were dealt with in one lesson instead of two lessons. The teacher also did not discuss all Web skills with the students before letting them practice at the computer. Another important factor was the short attention span of many students, which caused the teacher to split up the project into short lesson fragments.

Jointly, these factors contributed to the project being most of the time a couple of rather isolated lessons. The students were not particularly attracted to the idea of making a brochure. The resulting brochure itself was rather short and reflected the reading and writing problems of some of the students. Some of the texts were taken from websites verbatim. However, in the end all students contributed to the project. On the whole, Jonathan was not dissatisfied with the project. His impression was

that students learned a lot from the project, especially with regard to evaluating Web information.

4.2 Across-class comparison

Shaping the curriculum: collaborative inquiry and Web literacy

To what extent and in what ways did the teachers differ with respect to their implementing, organising and supporting the collaborative inquiry activities and their attention to both Web literacy skills and their relation to the project's theme? We distinguish six aspects, following the focal points that guided our data analysis.

Development of students' research questions. In all classes, students constructed their own research questions. In one class, this resulted in the teacher and students jointly constructing and modifying the research questions. This teacher discussed the usefulness of the questions with regard to the content of the brochure. Two teachers chose not to intervene in this process a great deal. In their opinion, students would be more motivated when working with questions of their own and also more challenged to find answers to those questions. Although they recognized the difficulty or inappropriateness of some questions, they either wanted students to find out for themselves what questions 'worked' and what did not or underestimated the consequences. In one class, merely practical circumstances such as time pressure and a lack of overview of all students' computer activities resulted in students mostly 'going their own way' with regard to making research questions.

It was assumed in the project that for children of this age, learning to critically search, read and evaluate Web information requires the formulation of rather concrete and factual research questions that make the finding of relevant information easier. The validity of this assumption may be illustrated by the consequences of the teachers' different approaches of the process of constructing research questions. Students who worked with concrete questions (either completely their own or negotiated with the teacher), experienced success when finding relevant information, which in turn resulted in higher motivation. Examples of such questions are 'Is wholemeal bread healthier than white bread?' or 'What food contains calcium?'. They also had the opportunity to practice the critical Web skills discussed in class since they found potentially useful information. In contrast, students who worked with either too difficult or inappropriate questions (for example 'Is healthy food always distasteful?'), spent most of their time with unfocused searching for information.

The relation between students' questions and the project goals. The project was aimed at the acquisition of Web skills in the context of inquiry activities on the subject healthy food. One teacher made such connection between students'

questions and project goals from the start and reminded students repeatedly of the usefulness of critical Web skills when working on the brochure. In this class, the students knew all the time that practicing those Web skills was necessary for their joint production of an informative and reliable brochure. When asked, these students related activities such as learning to recognise with what aim websites are made to their own process of writing texts for the brochure:

> "Well, in the brochure, everything must be right somehow. But on the Web you can also find a lot of nonsense. […] Then you must be sure you don't write that nonsense in the brochure, because then people can't use it."

The other three teachers tended to focus on the Web skills and to discuss these skills in isolation from the project's context. As a consequence, their students had difficulty with connecting their Web activities with the making of the brochure and were less motivated to work with the Web in such a focused way.

The ways the teachers supported the students' inquiry activities. Some practical circumstances influenced the teachers' ways of supporting students' Web activities. Especially the location of the computers in school proved to be important, since it was difficult for teachers to support students and to have an overall view of their computer work when computers were located throughout the school building. This was of course also influenced by class size. Both support of and reflection on students' Web activities were made easier with help of a computer projector. Web activities tend to be individual activities, as all students work at their own computer. A projector makes it possible to share students' Web activities with each other and to practice Web skills together, taking advantage of knowledge and skills students already possess. However, the ways teachers supported their students also reflected their different teaching styles. The two teachers that preferred working with spontaneous, student-initiated activities also tended to support students less directly and to leave the initiative for support with the students. Unintentionally, this often resulted in students not recognizing the necessity of using certain Web skills or strategies.

The collaboration between students. The classes differed with respect to the ways the students collaborated both in pairs and in the whole class. The teacher that succeeded best in connecting the acquisition of critical Web skills with the joint production of the brochure, paid explicit attention to collaboration, focusing especially on the necessity of sharing knowledge with other. She expressed her relying on students' helping each other. This turned out as she intended, since students felt they shared the same goal and realised that only together they would be able to make a valuable brochure. This was also reflected in the several ways students supported each other during computer work. In contrast, there also were

classes in which students did not look at the project as something they needed each other for.

Paying attention to Web literacy skills. With regard to the specific searching, reading and evaluating Web skills, it was striking that the teachers, as a matter of course, paid attention to searching skills. This aspect of Web literacy was addressed rather frequently at the schools, during students' Web activities. The project's focus on reading and evaluating skills was new to the teachers. Most of them found it more difficult to connect those skills to the students' inquiry activities. Although all teachers recognised the necessity of both reading and evaluating skills, in the lessons students' information seeking was sometimes unintentionally narrowed down to searching skills only. Teachers found it more difficult to address Web reading skills. Students were convicted that searching the Web was easy for them, and disliked the idea that reading skills were as necessary on the Web as with books. In fact, many students' preference for the Web as an information resource originated in their opinion that "on the Web you don't need to read". The students were most interested in the evaluating skills which appealed more to them, partly because the activities involved (e.g., discussing the McDonalds website and relating the from and content of websites of different origin).

Paying attention to content knowledge. During the project, students' research questions determined their coming across valuable content with regard to the project's theme, healthy food. Therefore, both quality and 'workability' of those questions were important for their learning. Students who worked with concrete and factual research questions on aspects of healthy food or healthy eating habits and who were able to find useful information, clearly learned from their inquiry activities. They had to read and process Web content when composing texts for the brochure. Because of the connection with the research questions, students came across different aspects of healthy food, varying from the necessity of eating breakfast to the difference between white and wholemeal bread, and from vitamins in milk to the amount of vegetables and fruit a child needs every day. The one class in which the students collaborated best, also shared the information they collected with each other, as was intended. As a result, they jointly built a 'body of knowledge' about healthy food which was in turn reflected in the brochure for their fellow students. The example of Langdon School students discussing and studying the nutritiousness of grasshoppers, is another example of shared knowledge through Web-based inquiry activities.

On the whole, the teachers' particular teaching style seems to have been determining the way the project worked out in their specific class. Both the Langdon

and the Norwood School teacher were used to work with spontaneous, student-initiated activities. They wanted to activate and motivate students for example by letting them not only compose their own research questions but also leaving the initiative for modifying these questions to the students and wanting them to find out for themselves which questions were 'workable' and which were not. Both teachers felt that the project's lay out and materials required something they did not really want to do, although they were convinced of the usefulness and necessity of the project's learning goals. Although one other teacher (from Kingsley School) also experienced many problems with his students' passive behaviour, he tended to respond with more control and teacher initiative, instead of leaving the initiative more to the students. The Milford School teacher seemed to have been most 'at ease' during the project; the project's lay out and content fitted her own teaching style.

Students' learning results: questionnaires

With regard to the learning results of the program in the participating classes, we will look first at the questionnaires. The questionnaires' knowledge items focused on healthy food habits and Web literacy skills. Table 2 gives an overview of students' mean scores for the four classes separately.

TABLE 2: OVERVIEW OF STUDENTS' LEARNING RESULTS (QUESTIONNAIRES)

	Kingsley School N = 18		Langdon School N = 23		Milford School N = 27		Norwood School N = 16	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Food items (N items = 10)								
before	7.11	1.94	7.26	1.51	6.19	1.84	6.13	1.15
after	8.11	1.32	7.48	1.93	7.59	1.42	6.69	1.49
Web skills items (N items = 15)								
before	11.89	2.30	11.35	2.27	11.59	1.78	10.19	3.23
after	13.17	1.04	12.57	2.61	12.56	1.78	10.19	2.83

With regard to the healthy food items, comparing means has only relative significance, as the students did not follow a fixed curriculum on this subject. The learning that could take place was necessarily connected to the student's own research questions. All class means are higher after the project, both Kingsley and Milford means reaching significance ($p < 0.05$). With regard to the Milford students, this may be interpreted in the light of the way the project was carried out in that class. The students from Milford School worked with rather good and 'workable' research questions, which were directly related to the subject of healthy food. Moreover, these students also shared the acquired knowledge with each other (much)

more than in the other classes. It could be that in this way the students gained more content knowledge, which is reflected in their answers. However, we are careful with such conclusion because the results of the Kingsley students are less easy to interpret; it may be that their Web searching has led to knowledge on aspects of healthy food addressed.

The analysis of students' answers to the items regarding the knowledge of Web literacy aspects shows that the mean scores of three of the four participating classes are significantly higher after the project ($p < 0.05$). The Norwood School students' results stayed the same. Again, we may only interpret this very carefully. At Norwood school, less attention was on the Web skills during the project, compared with the attention on healthy food. This may have affected these students' results on the questionnaires.

Students' learning results: final assignments

Three student pairs of mixed gender and reading comprehension level from each class performed six final assignments after the project. The assignments focused on students' actual Web use. Most student pairs began with searching with Google, and used other strategies only when they got stuck. Students appeared to be quite able to compose relevant keywords for their searches, although some pairs used spoken language or typed in the whole question as one search term. Students regularly scanned Web texts, looking for specific headings or clues in the text, as they had learned during the project. However, they also showed many instances of 'non-reading', i.e. overlooking relevant information or scanning very quickly without really looking for headings or key words.

Table 3 shows the adequacy scores of the student pairs on the two assignments that focused on both searching for and reading Web information. The scores show great variation both between students and between assignments. Better and worse performing students were found in all schools. Although the assignments varied in difficulty, assignment 1 being easier than assignment 2, this is not reflected in all student pairs' scores. There also seems to be no direct relationship between students' level of reading comprehension and their scores. Sometimes weaker reading pairs showed less adequate Web behaviour, but there are also examples of surprisingly high scores. Vice versa, strong readers (for example pair KS1, and also NS1 and NS2) did also show inadequate behaviour at one or more assignments. The differences between students seem to be related to their ability to reflect on their searching, and as a result to adapt their search strategy. The lowest performing students either continued to use the same, sometimes failing strategy, or (especially) tried many different strategies without much thinking. In fact, the highest scores in Table 3

reflect Web behaviour that combined relative good Web skills with both flexibility and patience.

TABLE 3: OVERVIEW OF STUDENT PAIRS' LEARNING RESULTS (FINAL ASSIGNMENTS)

	Student pair	Reading level [20]	Score assignment 1	Score assignment 2
Kingsley School	KS1 (2 boys)	A/A	0.85	0.50
	KS2 (2 girls)	D/D	0.61	0.29
Langdon School	LS 1 (2 girls)	A/C	0.94	0.77
	SS2 (2 boys)	B/C	0.66	0.52
Milford School	MS1 (2 boys)	B/C	0.66	0.83
	MS2 (2 girls)	B/D	0.81	0.48
	MS3 (2 boys)	C/D	0.92	0.27
Norwood School	NS1 (2 boys)	A/C	0.56	0.37
	NS2 (2 girls)	A/C	0.58	0.73
	NS3 (1 girl, 1 boy)	B/D	0.60	0.72

Inconsistency seems to be a prominent feature of many students' use of Web skills. The variances between their scores on the assignments are remarkably (see for example the pairs MS2 and MS3). Students also showed inconsistency within one assignment, alternating adequate actions with highly inadequate ones. Thus, although many students were able to use rather sophisticated searching and reading skills on certain moments during the assignments, they did not do so regularly. For example, students showed that they were able to compose relevant keywords in one assignment but failed to do so in another. This was only partly related to the degree of difficulty and type of the assignment.

Most students did not seem to plan ahead when searching on the Web. They seemed to act rather impulsively, which turned out well in some cases, and wrong in others. Many students simply 'tried out' one or more search strategies, including strategies they had learned to be not very useful. Almost all students could lose themselves in inefficient search strategies that seemed to make no sense. Reading Web information in particular proved to be a bottleneck for students, because reading requires patience. Students had already expressed their dislike of reading on the Web during the project. Also students' own habits when using the Web seemed to be very persistent.

Three assignments focused on various aspects of Web evaluating skills. In the project, students had come across several aspects of Web evaluating, such as

[20] On the basis of the scores on the CITO reading comprehension test, students are classified in one of five categories A, B, C, D or E; A representing the highest and E representing the lowest achieving students.

articulating their own opinion about the websites they visited, assessing the intentions of a website (e.g., 'advertising', 'providing information', 'giving an opinion on something', etc.) and assessing the relevance and suitability of websites. When asked to comment freely on a website on animal protection, almost all pairs mentioned the appearance of the site in their comments, either in a positive or in a negative way. Quantity of the information on the website was much mentioned, again either in a positive way ("it is good that there is much information") or in a negative way ("there is too much information"). Students also mentioned the quality of the information and the easiness (or difficulty) to find information on the website. Most pairs did not navigate deeply into the website as they had learned in the project and either stayed at the homepage or clicked at links without reading the information.

Almost all pairs could mention at least one intention of a given website (on wetlands protection) adequately; only one pair totally misunderstood its intentions. Students mentioned mostly some aspect of advertising and of 'giving an opinion'. Most students mentioned one label, although in the project they were told that most websites can be characterised by several labels. Two pairs did connect labels with each other, e.g. 'They want to raise money so they can better protect the wetlands'.

One assignment asked students to evaluate a specific website with regard to its suitability for children. The website (about safe Internet use for children) was aimed at parents and teachers, but due to its colours and fonts its appearance was very childlike. Only two pairs argued that the website was suitable for children. These pairs did not take the information or language into account or did connect that aspect of the website with its appearance. Most of the other pairs commented first on the website's colours and fonts, but also questioned its suitability for children because there was "nothing to do for children". Although an adequate observation, the website's information or language did not really play a role; one pair said that they did not know what the website was about and did not understand its intentions.

5_ Conclusions and Discussion

Our research aimed at studying the possibility of collaborative inquiry activities as a context for acquiring Web literacy skills. In a multiple case study design, we studied four 5th grade classes working on the subject 'healthy food'. Students used the Web to obtain information on healthy food with a view to making a brochure for fellow students. The teachers supported students' inquiry activities and stimulated that they encountered the need for Web searching, reading and evaluating skills when working on the brochure, which they then discussed and practiced with the students.

The learning results of the students show that thematic inquiry activities can provide a valuable context for teaching and learning Web literacy skills. Through working collaboratively with research questions with a view to a meaningful goal (i.e. making a brochure), students were confronted with all difficult aspects involved in Web use. All classes show knowledge gain with regard to the subject healthy food and all classes but one show knowledge gain with regard to Web literacy skills. With regard to students' actual Web behaviour, the overall impression is that the project has contributed to their Web skills. Although many students appear to be inconsistent, impulsive and impatient Web users, they also show many instances of adequate Web searching, reading and evaluating behaviour.

From the teachers' experiences with the project, we learn that there are several contextual factors that may influence the realization and results of embedding the acquisition of Web literacy skills within the context of thematic collaborative inquiry activities.

Firstly, teachers and students need explicit support and guidance with regard to formulating 'workable' research questions that are appropriate for the acquisition of Web literacy skills. Students who worked with such questions were able to practice and to improve their Web skills and found valuable information for the brochure. In contrast, students who worked with questions that were too vague or broad, did not find the required information, became discouraged and did not have the opportunity to use more advanced Web skills.

Secondly, the conditions for students working collaboratively deserve attention. Our results confirm the importance of collaborative inquiry activities being more than just 'working together'. Elements as teacher and students sharing the project's purpose, relying on each other's knowledge and skills, and students sharing knowledge require specific attention and effort from the teacher. The class situation in which such conditions were met, showed students who helped each other, who knew what everyone else was doing and who all shared the same goals. This resulted in a high motivation and an accumulation of knowledge.

Thirdly, the presence or absence of basic inquiry skills in students proves to be an important factor. These skills were supposed to be present, because of the teachers' and students' experience with inquiry activities. However, many students appeared to lack skills such as integrating pieces of information and recognizing information as contributing to answering one's research question. They were often looking for the precise answer to their question and were not (yet) able to recognize the value of bits and pieces of information they could use to compose the answer themselves. The Web reinforces such 'looking for the right answer' by its abundance

of information which gives children the idea that all answers can be found 'ready made'.

Finally, the correspondence between the project's proposed way of working and the teacher's teaching style deserves attention. Although all teachers had been selected on the basis of their similar views on education, they appeared to have rather different teaching styles which were reflected in the ways they carried out the project. Two teachers experienced tension between their own preference for spontaneous, student-led activities and the structure of the project materials. For example, they did not want to interfere much with the process of students developing their research questions. They expected the students to be active and motivated knowledge seekers as a matter of course. In this way, they underestimated the significance of their own contribution to the students' inquiry activities, and their role in modelling an inquisitive attitude.

Many students also appeared to need clear guidance and structure. Students liked the project primarily because they liked using the Web. The literature shows that many students appreciate the Web's appeared 'easiness': lots of information is only 'one mouse click away' (e.g., Watson, 1998; Large & Beheshti, 2000). This was reflected in the participating students' expecting easy results from their Web searching, and their being convinced of their own Web skills. The project asked them to approach their Web use differently, however. They were supposed to stay focused at their research questions, to search purposefully, and to read thoroughly and critically. This discrepancy between the students' expectations and preferred Web use, and the project's intentions required much structure, support and guidance from the teacher. Otherwise, students not only became discouraged but also seemed to 'escape' and to stay at their own preferred Web routines.

Overall, our results show that the project required complicated teaching skills as well as considerable time, effort and motivation. All teachers were of the opinion that acquiring Web literacy skills required more time and practice; at the same time, three of them thought the project was too long to keep students focused and motivated. All teachers suggested to spread out the teaching of Web literacy skills over more and smaller projects and over a longer period of time, preferably a school year. We agree with this suggestion: Web skills could then be taught in different projects with different themes, which could also be beneficial to the process of transferring the critical Web skills learned. Teaching the required inquiry skills may also be more easily incorporated into these smaller projects. One could argue that acquiring 'new literacies' such as Web literacy must be seen as basic skills just like

traditional literacy skills as reading, grammar and spelling. As a result, they require the same constant attention.

We also suggest to take better notice of students' own ways of using the Web. Some students looked at the project as something that had nothing to do with their own ways of using the Web. By taking them more seriously as participants, in the sense of already possessing valuable skills, a learning environment could be created in which both teachers and students could share knowledge and skills in collaborative activities.

Our research was aimed at studying the acquisition of content knowledge together with critical Web skills. This proved to be difficult for the teachers, who struggled with keeping a balance between these two learning goals and incorporating acquiring content knowledge in Web activities. Using the Web in inquiry activities may be difficult for students, teaching to use the Web embedded in inquiry activities is definitely not easy for teachers. The students' learning results show a mixed picture of students being able to use rather sophisticated Web skills, but also showing inconsistent, inflexible and impulsive Web behaviour.

In a parallel study on the acquisition of Web literacy skills, we embedded these skills in a structured educational program in which students worked with prescribed exercises instead of collaborative inquiry activities (Kuiper, Volman & Terwel, in press; chapter 2 of this thesis). This study shows more or less the same students' Web behaviour after the project. This suggests that both learning contexts may result in students acquiring valuable Web skills. What may then be the surplus value of embedding critical Web skills within collaborative inquiry activities? The one class in which the project's goals were best achieved, shows that students were able to relate the value and meaning of Web literacy skills to their own process of finding useful information for the brochure. They experienced the need to use the Web critically. Thus, learning Web literacy skills became a meaningful activity for them.

When observing the way students worked with the project's inquiry activities, we came across an interesting paradox for which our study offers no quick and easy answer. Although the Web potentially is a tool that can be used by students for active and meaningful knowledge construction, it also carries the risk of inviting just the opposite behaviour. The Web entices students to think every answer can be found ready-made on it, because of the abundance of information it offers. It also invites students to be more or less passive searchers, because of the speed with which lots of information appear on the computer screen. Developing valid and meaningful knowledge on the contrary supposes students to be actively involved in the learning process, to construct knowledge by connecting new information to

already acquired knowledge, and to reflect on this process and its results. This paradox illustrates that the Web not only offers many possibilities for learning, but also new challenges to teachers and students.

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Chapter 4

Students' use of Web literacy skills and strategies: searching, reading and evaluating Web information[21]

The Web is used extensively by students both in and outside school. Using the Web for knowledge construction, demands specific searching, reading and evaluating skills. This article reports on the adequacy and specific characteristics of 5th grade students' use of Web literacy skills and strategies after completing a program in which these skills and strategies had been the focus of attention. We adopted a exploratory approach to the data, which were collected in sets of 21 student pairs' Web use during six assignments and recorded with help of Camtasia screen recording software. The students' dialogues as well as their screen behaviors were transcribed. The quantitative part of the analysis focused on the extent of students' use of Web strategies and on the adequacy of those strategies, for which we constructed an adequacy index. The qualitative part of the analysis focused on the characteristics of (in)adequate Web strategies. Methods of data reduction, comparison and contrast were applied. Our results show that students' strategy use is characterized by differences in adequacy both between and within assignments. This can partly be explained by differences in students' use of searching, reading and evaluating skills and partly by specific patterns underlying their Web strategy use such as (in)flexibility, impulsiveness and a tendency to look only for 'one right answer'. The reflective use of Web literacy skills in particular seems to determine students' adequacy.

[21] Kuiper, E., Volman, M. & Terwel, J. (2006). Students' use of Web literacy skills and strategies: searching, reading and evaluating Web information. Manuscript submitted for publication.

1_ Introduction

The Internet is used extensively by children and teenagers, both at home and at school. At home, they communicate with friends through instant messaging, surf the Web to find information about the latest mobile phones, and create their own website or weblog. At school, the Web has become a popular information resource, and is increasingly used as an alternative to printed resources. Although many teachers acknowledge the Web's potential as an educational tool as well as the Web motivating power, they also struggle to find meaningful applications of the Web in their educational practices. The Web is a learning tool that differs from other tools used in education because students acquire a great many Web skills in an out-of-school context, and also regard themselves as skilled Web users. This is reflected in the perception of many teachers that their students' Web skills are superior to their own, which may result in underestimating the support students need when using the Web for educational purposes.

The Web has certain characteristics as its size, topicality and accessibility, as well as the use of hypertext and non-textual elements that are complicated for users and require specific skills. Many students use the Web quite naturally, but "Too often, students – and adults, too – mistake their ability to move around the Internet for the skills that they need to navigate and read it" (Burke, 2002, 38). This is confirmed by extensive research into children's Web behavior that shows children as lacking adequate search skills, as well as the necessary skills for critical evaluation of Web information. Although much research is based within the Library and Information Science (LIS) discipline, with its tradition in the study of information-seeking behavior (e.g., Bilal, 2000, 2001, 2002; Fidel et al. 1999; Shenton & Dixon, 2003), also reading researchers (e.g., Coiro, 2003) and educational researchers (e.g., Hoffman, Wu, Krajcik & Soloway, 2003) have focused on the Web as a new educational tool, requiring new skills and strategies from both teachers and students.

In our research we take an interdisciplinary approach in trying to combine the focuses of both LIS and educational researchers. LIS research points to the need for incorporating Web literacy, or, more broadly speaking, information literacy into school curricula. It provides knowledge about the information searching process and suggestions for application in practice (e.g., Eisenberg & Berkowitz, 1990; Kuhlthau, 2004). Educational researchers primarily look for ways of using the Web as a meaningful learning tool for knowledge construction (e.g., Hoffman, Wu, Krajcik & Soloway, 2003). Such use of the Web requires the mastery of certain strategies that in turn requires specific Web-related skills. In this article, we report on the adequacy and specific characteristics of students' use of Web skills and strategies after completion of a program in which these skills and strategies were addressed.

In our study of the students' Web behavior, we use 'Web literacy' as an umbrella term, encompassing a range of interrelated skills. From the literature, we derive three major components of Web literacy skills: Web searching skills, Web reading skills and Web evaluating skills (see for example Coiro, 2003; Enochsson, 2005; Sutherland-Smith, 2002; Shenton & Dixon, 2003). The Web's size and topicality require good **Web searching skills** in finding the information one is looking for, for example, knowledge of various ways to locate Web information and the ability to formulate relevant keywords. **Web reading skills** may be seen as a combination of traditional reading skills and new skills that are needed in the light of the Web's 'information overload' and hypertext environment. Because most Web texts are not written for children, effective technical and comprehensive reading skills are required. The Web's use of hypertext and its multimodality require specific reading skills to be able to find one's way, in order to distinguish between potentially valuable and useless information, and to identify the meaning of non-textual elements. Flexible use of scanning and close reading techniques is also an example of Web reading skills. Finally, the Web's open character and accessibility appeal to **Web evaluating skills**, i.e. the ability to critically assess the reliability and authority of Web information with a view to one's own information needs.

Empirical research into teaching Web skills and strategies is relatively scarce and mostly aimed at upper-grade and university students (e.g. Walton & Archer, 2004). Our research aims at teaching Web skills at 5th grade primary school level. We designed and evaluated two programs on teaching Web literacy skills in the context of a class project on healthy food, one program being essentially sequential and pre-structured, the other focusing on collaborative inquiry activities in which the Web was used for students' own research questions (see chapter 2 and 3 of this thesis). In both programs, we paid attention to all three subcategories of Web literacy, i.e. Web searching, Web reading and Web evaluating skills and strategies (see Appendix 1). The learning results of both programs show that students gained knowledge of Web literacy skills, which is, however, not quite reflected in the actual Web behavior they showed in assignments after the projects. Although many students show instances of adequate searching, reading and evaluating behavior, they alternate this with inadequate use of the Web, e.g., by formulating proper search terms for one assignment but failing to do so for another. For both LIS and educational practices it is important to identify the origins of students' varying Web behavior, with a view both to the conceptualization and teaching of Web literacy. For this reason, we look more precisely in this article at the way students used the Web during assignments after the programs. We formulated the following research questions:

a. Which Web searching, reading and evaluating strategies do students use?

b. How adequate are students' Web strategies?

c. What are the characteristics of (in)adequate Web strategies?

2_ Method

2.1 Study design

With a view to these research questions, an exploratory approach was appropriate, since we aimed at both a systematic description of students' Web strategies and an exploration of possible explanations of their (in)adequate Web use (Robson, 2002). In our study, we used data from the case studies we conducted earlier in our research into teaching Web literacy, as described in chapter 2 and 3 of this thesis.

2.2 Participants and Data collection

Eight 5th grade classes participated in our research. From each class, three student pairs were selected to perform final assignments after the programs had ended (a total of 24 pairs). Most of these pairs consisted of either boys or girls, but some were mixed gender couples. In general there was at least some heterogeneity with regard to students' level of reading comprehension. The final assignments deliberately focused on their ability to use the Web searching, reading and evaluating skills addressed in the programs in other topics and contexts. Although Web literacy should be seen as a set of connected sub skills that must not be separated and are all important in Web activities, we wanted to be able to look more precisely at the way the students used the skills and strategies that were at the centre of the projects. Students received six assignments, each focusing on particular aspects of Web literacy. Appendix 2 shows all assignments, the skills they intend to measure, as well as the type of task.

Students' use of Web searching, reading and/or evaluating skills and the adequacy of their strategies were investigated through assignments 1, 2 and 3. In assignments 1 and 2, students were asked to find a specific answer on the Web. They were free to use the Web as they wanted, which made it possible to observe their spontaneous Web searching, reading and evaluating strategies and skills. The assignments differed in level of complexity, assignment 1 being more simple and straightforward, while assignment 2 was more complicated both with regard to the phrasing and the difficulty of finding the right answer. Assignment 3 focused more exclusively on reading skills. This assignment provided students with a particular website and asked

them to search specific information on that website. Searching and evaluating skills were less important in this assignment.

Students' use of **Web reading and evaluating skills and the adequacy of their strategies** were also investigated in assignments 4, 5 and 6, which were of a different nature. These assignments did not require students to find an answer on the Web, but asked them to give their comments or opinion on elements of Web evaluation. We wanted to compare such contemplative use of evaluating skills with the students' use of these skills during their Web searches. Assignment 4 asked students to mention positive and negative elements of a website on animal protection. Students had been taught to pay attention to several aspects of evaluating Web information (such as assessing a website's author and intentions and assessing its reliability and relevance) and to navigate thoroughly through a website to be able to give an opinion on those aspects. In this assignment, we wanted to know which elements of a website students mentioned spontaneously and how they arrived at their opinions. In assignment 5, students had to formulate the purpose of a website on Dutch wetland areas, an aspect of evaluating websites that had been prominent in the lessons. The teachers had discussed the main purposes of several websites with the students, using labels such as 'providing information', 'giving an opinion on something', 'advertising' (either commercial or non-commercial), 'fund raising', 'entertaining' etc. Students were told to look for more than one intention, as many websites, in fact, show a combination of intentions. Assignment 6 asked students to discuss the usefulness for children of a particular website (on safe Internet use). Determining the usefulness of a website was one important element of the lessons on evaluating Web information. Although the website's appearance was very childlike, due to its colours, fonts etc., it appears to be written for parents and teachers when evaluating its content.

The time students spent at each assignment was recorded. Students were given approximately one hour for performing all assignments, with a time limit of about 12 minutes for each assignment. All assignments had been tried out previously by students of the same age and, where necessary, adapted. All student sessions were captured on Camtasia screen recording software, which also recorded the conversation of the student pairs. Students worked in a separate room and with a university notebook equipped with the necessary software, to prevent problems due to technical restrictions of the school computers. During the assignments, students were stimulated to discuss their way of working with each other. One researcher was present at all sessions and made supplementary notes about the way students worked together and carried out the assignments. We collected data on students' reading comprehension level as background information. Due to students' illness and

technical (software) problems some loss of data occurred. We used 21 data sets from the assignments 1, 2 and 3, and 15 data sets from the assignments 4, 5 and 6.

2.3 Data analysis

All Camtasia recordings were transcribed twice: students' conversations were transcribed verbatim, and students' screen activities were written down. A transcription sample is given in Appendix 3. The transcripts were analyzed both quantitatively and qualitatively.

The quantitative analysis focused on our first two research questions: the Web searching, reading and evaluating strategies students used as well as the adequacy of these strategies. To get an overall picture of students' strategy use, the recordings and transcripts of the assignments 1 and 2 were analyzed with the help of a list of Web searching, reading and evaluating strategies the program had paid attention to (see Appendix 1). All strategies the student pairs used in these assignments were classified and counted. In this first analysis, we took all students together and made a clear distinction between Web searching, reading and evaluating strategies. However, especially with regard to searching for and reading Web information, the use of a certain strategy does not provide information about its adequacy in the context of a specific task or question. For example, using only one keyword when searching on Google may be an adequate strategy in the context of the Madagascar-assignment (see Appendix 2), but inadequate in the context of another task. Therefore, we decided to construct an adequacy index and designed a coding procedure in which each separate reading and searching activity was first coded and subsequently scored as either 0, 0.5 or 1 depending on its adequacy in the context of the specific task. Appendix 4 shows the coding scheme, with the definitions used to identify activities and examples. These scores were added and divided by the total amount of reading and searching activities each pair had performed during that assignment. In this way, an overall score (between 0 and 1) for each student pair's adequacy in using Web searching and reading strategies was calculated. The reliability of the coding procedure was calculated by coding approximately 50% of the activities twice, by two independent researchers (Cohen's kappa =.87). The results of the quantitative analysis are reported in section 3.1.

The qualitative analysis focused on our third research question: the characteristics of (in)adequate Web strategies. First, the transcripts of the student pairs' dialogue and screen behavior during the assignments were analyzed with a view to describing and identifying the Web skills students used, with the help of the list of skills in Appendix 1. Students' Web searching and reading skills were described and counted. Students' use of Web evaluating skills was determined by both describing their spontaneous use of these skills during the first three assignments and their elicited

use of these skills during the last three assignments in which they were explicitly asked to discuss certain aspects of Web evaluation (i.e. the quality, intentions or usefulness of a specific website). We report the results of this first part of the qualitative analysis in section 3.2.

Second, we analyzed the transcripts with a view to identifying patterns that explain students' (in)adequate Web strategies, using a content analysis approach (Miles & Huberman, 1994). We focussed on differences in the strategies of student pairs with different adequacy scores and on the strategies leading to unexpected scores (e.g., students with comparable reading comprehension scores but different adequacy scores, and students pairs that performed very inconsistently). By constantly comparing and contrasting the performances of student pairs, we identified a number of patterns underlying the adequacy scores. This second part of the qualitative analysis is discussed in section 3.3.

3_ Results

3.1 General analysis of students' use of the Web: strategy use and adequacy

With regard to Web searching strategies, Table 1 shows that students preferred using Google. They regarded Google as an easy way of searching the Web, arguing that "you can find anything there" and "you only have to type in some terms and then Google finds it." They were able to use other search strategies, but did so only occasionally, although they had been introduced to a variety of strategies. The differences in complexity and difficulty between the assignments gave rise to students' use of either single or multiple search terms, assignment 2 encouraging, much more so than assignment 1, the use of multiple search terms (see also Appendix 2). Specific characteristics of the tasks were also reflected in greater use of directory pages in assignment 1, and greater use of search options within a specific website in assignment 2. With regard to students' Web reading strategies, the 'non-reading' category stands out in that during both assignments students showed many instances of literally overlooking the right answer or overlooking a menu or link where the answer could easily have been found. Students frequently used a scanning technique when reading websites, as they had learned during the projects. Surprisingly, assignment 2 shows a smaller amount of reading than assignment 1. It seems as if the more complex and difficult assignment 2 resulted in more searching for relevant websites, but fewer attempts to access, and thus read, Web texts. Evaluating websites or Web information occurred with a view to determining the usefulness of a site, with students looking mostly at its relevance for the specific task.

Students never questioned the reliability of the websites they accessed during these assignments.

To assess the adequacy of students' Web searching and reading strategies in particular, all student pairs' Web activities during assignments 1, 2 and 3 were scored (see Appendix 4). These assignments asked students to find an answer on the Web, either by searching freely or on a given website. Table 2 shows all students pairs' scores, together with their reading comprehension level and the time they spent at each assignment. Students' scores and times show great differences, both within and between assignments. The differences between the assignments are reflected in both the mean scores and the mean time spent on the assignments. Assignment 3, in which students had to search an answer on a specific website, was relatively easy and consequently shows the highest mean score and the lowest mean time. The complex assignment 2 resulted in the lowest mean score and the highest mean time, while 9 of the 21 student pairs failed to find the (complete) correct answer. However, there are several exceptions to this general tendency of students getting better scores on assignment 2 when compared to assignment 1, or even with assignment 3. Differences (within assignments) between student pairs are expressed in the wide range of scores on the first and second assignments in particular, which vary from.34 to.94 and from.23 to.83 respectively.

3.2 Characteristics of (in)adequate Web strategies: which Web skills do students show?

In the course of the programs, students had learned various Web searching, reading and evaluating skills (see also Appendix 1). In this section, we take a closer look at the skills students showed to master during the assignments.

Students' use of Web searching skills

In the course of the programs, the students in our study had learned that when searching the Web, they first of all need to know what they are looking for. They had learned a variety of Web searching strategies, as well as the possibilities and limitations of those strategies and the skills they require. For example, using a search engine means that one has to be able to define appropriate search terms. In the former section we mentioned students' overall tendency to use Google. Most of the times they did not choose this search strategy deliberately and only used another strategy when they got lost in Google or when expecting easy results from a different strategy. For example, in assignment 2 some student pairs began by typing the URL of the newspaper that was mentioned in the assignment. Students also frequently used a search option on a website they found through Google.

The fact that students predominantly use Google has consequences for the skills that are required. In light of this, our focus was primarily on Google-related skills. Appendix 1 gives an overview of relevant searching skills when using Google, which the students had been introduced to during the lessons. With regard to **correct spelling of search terms**, most students were either able to avoid spelling errors or corrected themselves when committing such errors. Five pairs (of 21) committed spelling errors, all of them in assignment 2.

TABLE 1: STRATEGIES USED BY STUDENTS DURING THE ASSIGNMENTS 1 AND 2

Web-searching		**Assignment 1**	**Assignment 2**	**Total**
1. Google - one search term		20	7	27
2. Google - multiple search terms		19	41	60
3. Google - whole question as search term		3	8	11
4. Google - spoken language		2	11	13
5. Other search engine		2	2	4
6. Specific URL		2	6	8
7. Directory page		11	2	13
8. Children's search engine		1	3	4
9. Search option within a specific website		1	10	11
	Total	*61*	*90*	*151*
Web reading				
1. Reading text on a website verbatim		9	7	16
2. Scanning text on a website (using keywords, headings)		39	25	64
3. Using the menu on a website		16	4	20
4. Using links on a website		7	2	9
5. 'Non reading': Scrolling through Web texts or search engine results, or clicking websites away, without reading or using relevant keywords/clues		21	31	52
	Total	*92*	*69*	*161*
Web evaluating				
1. Evaluating one's understanding of Web information		2		2
2. Evaluating the reliability/authority of Web information				
3. Evaluating the usefulness of Web information		13	15	28
	Total	*15*	*15*	*30*

TABLE 2: ADEQUACY SCORES, TIMES AND RESULTS OF ALL STUDENT PAIRS' PERFORMANCES FOR ASSIGNMENTS 1, 2 AND 3

Student pair	Reading score	Score ass. 1	Time ass. 1 (min/sec)	Right answer	Score ass. 2	Time ass. 2 (min/sec)	Right answer	Score ass. 3	Time ass. 3 (min/sec)	Right answer
1 Timothy/Hawid	46/35	.53	8.00	Y	.45	11.00	half	.64	8.30	Y
2 Mark/Gholam	52/39	.75	6.00	Y	.70	6.30	Y	.75	9.00	Y
3 Saira/Fathma	36/29	.34	12.00	N	.23	12.00	N	.54	8.30	Y
4 Tim/Simon	68/39	.94	1.30	Y	.50	12.00	N	.77	5.00	half
5 Rachid/Ismail	43/39	.61	7.30	half	.69	8.00	half	.67	7.00	half
6 Kimberley/Rachelle	47/n.k.	.60	6.00	Y	.69	4.00	Y	.54	8.30	Y
7 Robin/Nena	63/50	.60	10.00	N	.75	6.00	Y	.94	3.30	Y
8 Niels/Donny	61/25	.58	4.00	Y	.78	4.30	Y	.81	4.00	Y
9 Jim/Ashley	50/47	.54	6.00	Y	.31	12.00	Y	.81	5.00	Y
10 Hannah/Lisa	59/44	.69	7.30	Y	.43	3.00	Y	.78	3.30	Y
11 Jamie/Mitchell	61/29	.67	7.30	Y	.72	8.00	Y	.63	4.30	Y
12 Rosa/Tess	66/29	.70	3.30	Y	.41	11.00	half	.70	5.00	Y
13 Steven/Vincent	68/61	.85	1.30	Y	.50	12.00	N	.88	4.00	Y
14 Sana/Dunya	35/32	.61	2.30	Y	.29	12.00	N	.81	3.00	Y
15 Emma/Josy	63/48	.94	2.30	Y	.77	4.00	Y	.88	2.30	Y
16 Nick/Sander	49/47	.66	4.00	Y	.83	3.30	Y	.94	4.00	Y
17 Nadia/Melanie	55/32	.81	4.00	Y	.48	11.00	Y	.93	5.30	Y
18 Will/Patrick	38/29	.92	2.30	Y	.27	12.00	N	.78	6.30	Y
19 Edwin/Pim	A/C	.56	4.30	Y	.37	12.00	N	.88	4.00	Y
20 Suzy/Rosan	A/C	.58	5.30	Y	.73	5.30	Y	.80	4.30	Y
21 Wendy/Jerry	B/D	.60	8.00	Y	.72	3.30	Y	.66	6.00	Y
Mean:		*.70*	*5.30*		*.57*	*8.20*		*.78*	*5.20*	

Although the first assignment had one difficult word (Madagascar), all students checked their spelling when typing this term. Their mistakes in the second assignment concerned simple Dutch words and were partly related to the students' general spelling problems; two pairs mainly made mistakes because of carelessness.

Steven and Vincent are two bright students who use the Web rather fluently. Especially when working on the second assignment, they made many spelling mistakes in ordinary Dutch words they failed to notice.

Such mistakes did not affect students' searching results when using Google, because Google corrected the mistakes itself (i.e. by suggesting a search term with correct spelling). However, when using a search box on a specific website, the mistakes did influence the search results.

Composing relevant search terms to a great extent determines Web searching results. Students differed greatly in their ability to compose relevant search terms, which particularly affected their results in the second assignment. In the first assignment, half of the pairs used a single search term ('Madagascar'), the other half included the word 'language' in their search term. Both strategies resulted in finding at least one particularly relevant website. With regard to assignment 2, searching was much more complicated: the assignment included more potentially relevant

search terms, thus asking students to choose the best combination, and although the right answer could be found on several websites, these websites were partially quite obscure and/or the information was rather difficult to find. Students used a variety of search terms in this assignment, varying from highly effective ones to typing in the whole question, accompanied by a question mark.

Although most students already regarded themselves as skilled Web users prior to the lessons, students' Web use in the second assignment showed that many students were not aware of the way search engines such as Google operate. They used irrelevant words as 'which', 'and' or 'the', or spoken language, without realizing its consequences or not understanding why leaving out words did not affect the search results.

> Saira and Fathma spent a lot of time on assignment 2. They tried out several search terms, mostly sentences derived from (part of) the literal text of the assignment. In a postmortem on their performance afterwards, the researcher gave some alternatives for the search terms they used, e.g., "algemeen dagblad doughnuts' instead of "the newspaper the Algemeen Dagblad and best doughnuts". They were very surprised: "Algemeen dagblad doughnuts, that doesn't make sense, he [Google] doesn't understand that".

In addition, nine student pairs consistently chose the Google option to restrict searching to Dutch websites; twelve pairs did not choose that option. Most students did not distinguish between Dutch search terms (as in assignment 2), which logically only could deliver websites in Dutch, and a search term such as 'Madagascar', which could give also access to non-Dutch websites. Students never took the number of results Google produced into account, although in the lessons they had been introduced to the relevance and meaning of that number to decide to broaden or narrow a search strategy. Overall, the skills taught during the programs were only partially applied by the students during the assignments.

Students' use of Web reading skills

The students had been introduced to both differences and similarities between general reading skills and Web reading skills that are specific to the Web's 'information overload' and hypertext environment. They had learned that when using the Web as an information resource, their reading begins when (using Google) they are shown, a frequently endless, list of search results. The heading and short text referring to a specific search result offer information about its usefulness and skilful scanning through these lists may define success or failure to locate relevant information. Students also had been taught to relate their reading to what they were looking for and thus to what they wanted to know, and had learned to reflect on their understanding of the information found.

How did the students in our research 'read the Web'? And to what extent did they use the complicated skills mentioned above? During the assignments, all students showed at least some ability to use a menu, to use links, to navigate deeply into a website and to scan Web texts. In these respects, some of them were quite fluent Web users. Yet, they also showed many instances of 'non-reading', i.e. of overlooking the right answer or a clue (menu, heading) for finding it, as well as overlooking relevant websites when scanning Google's results, and/or looking for an answer on a website that had nothing to do with the assignment, etc. Students also tended to read only parts of Web texts and to click away sites with too much text or an overly complicated structure. One could say that although students knew how to deal with hypertext elements, they often failed to use 'ordinary' reading skills when using the Web. This was especially remarkable with regard to students who were rather good 'conventional' readers.

Tim and Simon come across the website of the newspaper mentioned in assignment 2 and find a page with search results about the doughnut test. While the first result has both a clear heading ('Best doughnut this year in Gouda') and an answer entirely provided in one sentence, the students click on the second link on the page that has the heading 'Nasty, greasy and sometimes delicious'. When this page offers no answer, they return to Google's search results.

Robin and Nena are good readers and careful Web users, who take their time. Although they do search in the right way, they constantly overlook relevant headings and links. This results in a failure to find the answer to the first assignment.

Especially with regard to the Web reading skills, the nature of the assignment affected the students' use of the reading skills they had been introduced to. Most students seemed to be quite able to locate information on a particular, not too complicated website when they knew the information must be there. Table 3 shows that students performed quite well on the third assignment, which investigated the way students navigated on a particular website, and the reading skills and strategies they used to find the required information. When looking more closely at the students' performance, differences between the students do not seem to be primarily related to specific Web reading skills but more to navigational skills and efficiency in using these skills. For example, the particular website had to be opened by clicking on the word 'Welcome' at the homepage, or by selecting a menu that popped up when scrolling the screen. Although some students lost some time by pursuing the wrong track for a while, most of them quite easily found the right links to follow. Students differed in their reading speed and strategies, some scanning and others closely reading all texts, but almost all found the required answer. Thus, efficiency rather than effectiveness seems to be the distinguishing factor in students' behavior.

When comparing students' use of Web reading skills during the first three assignments, it became clear that assignment 3, in fact, resembled assignment 1 in one respect. Almost all students came across one particularly relevant website when working on assignment 1, on which the answer could easily be found through the use of a clear menu. Many students totally overlooked this menu, while they proved to be able to look for, and use, menus very effectively when inspecting the website given for assignment 3. This suggests that the students somewhat paradoxically tended to overlook meaningful clues on a website when they were not sure it would offer them the right answer. More generally, this could mean that students tend to use less appropriate Web reading skills when asked to search freely, as opposed to search at a specific website.

A similar observation concerns the differences between students' Web reading during the assignments 4, 5, 6 and 7. Although all of these assignments asked students to access a specific website, and thus to read its contents, students showed different reading behavior during these assignments. While quite effortlessly navigating deeply into the website given in assignment 3, many of the students stayed mainly on the websites' homepage for assignments 4, 5 and 6. This could be a matter of 'laziness' but may also suggest that the need to find a specific answer elicits different ways of Web reading behavior to being asked to from one's own opinion on a website or to evaluate the main purpose of a website.

Web reading skills seem to be pervasive through all forms of Web use, but the relation between students' level of conventional (comprehensive) reading skills and their reading on the Web is not unequivocal. Our results show examples of students whose lack of conventional reading skills interfered with their effective use of the Web in several ways. However, not all 'strong readers' in our study performed better than the 'weak readers', and not all 'weak readers' performed poorly.

Students' use of Web evaluating skills

Students had been introduced to the differences between the Web and (non-fiction library) books during the lessons on evaluating Web information, and had discussed the problems involved, such as the abundance of unauthorized information. Three main aspects of Web evaluation had been addressed in the lessons: assessing their own understanding of the information found, assessing the reliability/authority of that information and assessing its usefulness/relevance. Understanding the information was closely linked to Web reading. Assessing the reliability and authority of Web information had been discussed by presenting the students with three questions they needed to ask themselves when visiting websites (the 'three Ws'): who is the author of this website, which intentions has this website (or: why is it made), and which kinds of illustrations or pictures does this website contain?

The students' use of evaluating skills was assessed in two ways during the assignments. First, assignments 4, 5 and 6 asked the students to comment on the pros and cons of a given website, to formulate the purpose behind a website, and to comment on the usefulness for children of websites. Secondly, the students' use of evaluation skills in practice was assessed by assignments 1 and 2. During Web searching, the evaluation of websites and Web information is important to avoid following wrong tracks, and to assess the relevance and reliability of information found. Although during the assignments both aspects came to the fore, the students in our study mainly looked at the usefulness of a website for finding an answer. They explicitly or implicitly decided many times about whether to click on, or explore a particular website, arguing "this must be it", "no, I don't think we can use that", "that's not about Madagascar" or "no, that says something about 2002 and what we need is 2004". However, they did not always use the correct arguments, as was shown in the section on reading skills. In other words, they looked for the relevance of specific Web information but failed in their elaboration.

During assignments 1 and 2, students never questioned the reliability of the websites they visited. At best, they asked themselves what a specific website was about, without accepting the consequences when they did not know. With regard to the first assignment, this had only minor consequences because the question was rather simple and students were easily able to find a particular relevant and reliable website. However, when working on the second assignment, students were confronted with all sorts of websites, varying from newspapers websites to weblogs and from bakery websites to satirical websites about doughnuts. The right answer could be found on a range of websites. The students in our study treated everything they found as 'factual information' and neither distinguished facts from opinions, nor questioned the reliability of the information found or of the intentions of the author.

> While searching for the answer to assignment 1, several students came across a weblog called 'Peter29'. They all began reading its text without looking at the website as a whole. Two pairs thought that the bakery they are looking for was called Peter.

In other words, all websites were treated equally as 'potentially offering the right information'. This may reflect students' being used to assignments in which they are requested to answer questions about a particular text, presented and thus authorized by the teacher. They may not adapt their strategy to assignments in which they are asked to use the Web, which is open and unauthorized.

However, both during the projects and during assignments 4, 5 and 6 students appeared to be able to distinguish between several types of websites, as well as to identify the main purpose of a website and to critically question a website's reliability (although rather superficially and without navigating deeply into websites).

For example, during the programs students had to comment on the website of McDonalds (www.mcdonalds.com). Almost all students were very critical of the website and questioned its intentions, arguing that they found it quite ridiculous that McDonalds should make such a healthy looking website while "everyone knows you grow fat at McDonalds". They also could distinguish between the intentions of a website of the meat industry and of vegetarians, and could comment on the way information about eating meat was presented on these websites. However, they did not use these kind of practices when asked to use the Web to find an answer on concrete assignments. Perhaps a somewhat 'trivial' question about a doughnut test as in assignment 2 does not elicit such critical Web behavior.

3.3 Patterns underlying students' (in)adequate Web strategies

A mere description of students' Web literacy skills does not explain the students' ability to use the Web adequately. Many students showed inconsistent Web behavior. Their performance varied between the assignments, i.e. they performed better on more difficult assignments or showed varying adequacy scores (see Table 3). Also, performance varied within one assignment, e.g. by alternating effective actions or strategies with highly ineffective ones. From our results four patterns emerged that underlie students' (in)adequate Web strategies and that affect the adequacy of their interaction with the Web.

(In)flexibility

Flexibility appears to be important for adequate Web use: the ability to alternate strategies, depending on their success. Many students in our study showed inflexible Web strategy use: they stuck to one particular search strategy despite lack of success, either because they were convinced of the appropriateness of their approach or because they expected Google to find the answer for them regardless of their own strategy use.

> Tim and Simon are two boys who carried out the first assignment very effectively, resulting in an adequacy score of .94 in only 1.5 minutes time. They used good search terms and worked in a very focused way. Especially Tim was convinced of his own Web skills. They confidently started the second assignment. After some time, they found a website about a doughnut test in 2002. Being convinced that their search strategy was effective, they continued looking at Google's search results, arguing that "We found 2002 in this way, so somewhere around here there must be a website about 2004". They continued 'browsing' through Google, scanning all websites. Even when they arrived at the 20th page, the 200th result, Tim, in particular, remained convinced that "it must be somewhere around here".

Such inflexibility was related to many students' profound belief in Google's power to find relevant information. They rather naively appeared to rely on Google.

Kimberley and Rachelle were searching on Google with the search term 'Madagascar which language'. One of the first results was a website about the language of Sri Lanka, given both in the heading of Google's search result and on the particular website itself. Kimberley and Rachelle began to read the website and write the language spoken at Sri Lanka down as the answer. After the session, the researcher repeated their search strategy and showed them the heading of the website. The students were confused: "We typed in Madagascar and then, well we thought everything is about Madagascar".

Sana and Dunya typed in the whole text of assignment 2 in Google's search box. This resulted in only three (irrelevant) results. Both students were surprised: "How is that possible, how is it possible he [Google] doesn't know that?"

This also seems to be related to the students expecting some sort of 'intelligence' from Google.

Jim and Ashley used Google to find an answer to assignment 2. One of the search results said in its heading "best doughnut this year in Gouda". The students decided not to look at this site because "it is about this year and we should be looking at 2004" (students worked on the assignments in spring 2005). Subsequently, Ashley suggested that they change the search term and write 'last year' instead of '2004'.

Although not all students 'trusted' Google to a similar extent, their Web use reflected the same tendency. They 'knew' that the answer could be found through using Google, and failing to do so often resulted in questioning Google instead of questioning their own strategy. This also affected the students' Web reading since they did not spend sufficient efforts on reading Google's results critically. This resulted either in their ignoring relevant websites or picking out irrelevant ones, without looking at a heading or search result.

Impulsiveness/patience

'Trial and error' was a much used strategy by students. In fact, this may be an efficient way of trying out which strategy is worthwhile exploring further. However, the students in our study did not use trial and error in such a conscious way. They either tried out several search strategies from the beginning without much thinking, or continued to adapt their search strategy when initial success did not materialize. They also tended to change their search strategies rather impulsively.

Rachid and Ismail were using effective search terms for their second assignment. When failing to find the right answer right away, they removed all search terms and replaced them by others.

The Web reinforces impulsive behavior because of its speed and ease of use; students are able to change tactics without much effort. Thus, patience seems to be a relevant component in adequate Web behavior. As Web users many students in

our study appeared to be impatient, impulsive and/or careless, regardless of their Web skills. They either were unaware of this, or seemed to underestimate its effect. Bright and confident students trusted their own capacities to such degree that they did not even look at their own spelling mistakes.

Steven and Vincent, two bright but also rather careless Web users, simply tried something else when their misspelled search terms did not produce the desired results.

Focus on 'finding the right answer'

Students' tendency to 'rely on Google' also has to do with their focus on 'finding the right answer' when using the Web, which is also mentioned in other studies (e.g., Wallace et al., 2000). The rather factual assignments used in our study may have reinforced such behavior. However, we saw similar behavior during the programs preceding the assignments in which students used the Web to find information for their own research questions. This tendency had repercussions for students' Web searching, their reading as well as their evaluating strategies. When scanning Google's results pages or scanning particular websites, they primarily looked for the answer itself or very strong pointers to the correct answer. When scanning Web texts, they either searched for the exact answer or for clues in the exact wordings of the assignments. Thus, they tended to overlook relevant (parts of) websites that used different phrasing or words or, conversely, explored irrelevant parts that used the words they were looking for. This affected, in particular, assignment 2, which used quite elaborate and complex phrasing.

Rachid and Ismail found part of the right answer on a website. They hesitated to write it down, arguing "This one talks about the most delicious doughnuts, it does not say anything about the best doughnuts."

Nadia and Melanie were scanning Google's results of their search term 'best doughnuts 2004'. They clicked on a page that mentioned 'Best doughnuts' in its heading, which is, in fact, the website of a swimming club. They scanned its text carefully, only looking for a reference to December 2004, instead of looking for the usefulness of the website. They clicked on a link 'photos doughnut party December 2004', and even explored the photos further.

Tim and Simon were scanning Google's results. Because they found a website about the best doughnuts of 2002, they went on to look at the results but only scanned for the clue '2004'. Thus, they overlooked several websites on which the answer could be found.

Kimberley and Rachelle had already found half the answer and only needed to know the name of the bakery asked in assignment 2. As a result they only looked for names when scanning Google's results, and thus clicked on several websites that had nothing to do with bakeries or doughnuts but carry a personal name in its heading.

Students' tendency to look for the right answer also resulted in their lack of questioning of the reliability of the information found or of the intentions of the author. They treated everything they found as 'factual information' and did not distinguish facts from opinions.

Reflection

Generally speaking, students' ability to reflect on the use of their Web strategy seems to underlie the patterns mentioned above. Our study indicates that Web literacy skills appear to be necessary, but not sufficient for adequate use of Web strategies. They do not result in finding the required information without reflection on one's search process and using this for adapting one's strategy. Thus, Web literacy skills as well as the flexible, patient and open-minded use of these skills together determine students' adequacy in using the Web. This may be illustrated by the following examples.

Emma and Josy had consistent high adequacy scores and worked fast. Emma is a smart student with high reading comprehension scores, Josy is a moderate student and reader. They were focused on the tasks at hand. They did not click at random at websites found with Google, and knew how to scan Google's results efficiently. This proved its value for the second assignment in particular. They composed relevant keywords and used Google's list of results to obtain a first impression of the usefulness of the websites found. Twice they made a mistake, but in both cases they were able to correct themselves and to modify their search strategy, i.e. to refine their search terms. They also kept their task in mind while looking at websites. After having initially clicked away a relevant website, they realized it might be useful after all while scanning other sites: "This one is not about …. What does it say in the assignment, when was it? December 2004, oh, but then it must be that first one, we will have to look there again".

Saira and Fathma are both students with spelling and reading difficulties. They wanted to perform well. From the beginning, they worked rather impulsively and did not take time to read Google's results. They were not able to compose good search terms and repeatedly typed in the whole question as search term. Sometimes they scanned and read Web texts on websites extensively, but they also clicked websites away without any reading at all. They mostly focused at only one or two words in the assignment, for example '2004' or 'December'. They repeatedly thought that they 'knew what to do', and easily became frustrated when not being able to find the right answer in a short time. Although they sometimes were able to correct themselves (for example, recognizing that a website was not about Madagascar), they either did not adapt their search strategy, or changed it radically

without reason (e.g., by deleting all keywords and typing new ones). This resulted in loss of much time. Their lack of success made them dispirited and even more persistent in using 'trial and error'.

4_ Conclusion and Discussion

In this study we looked at students' use of Web literacy skills and strategies during assignments after a program in which they were introduced to various Web searching, reading and evaluating skills and strategies. Our research questions focused on the students' use of Web strategies, the adequacy of their strategy use and the characteristics of (in)adequate Web strategies.

With regard to students' **strategy use**, they appeared predominantly to use Google when searching the Web. They used both single and multiple search terms, depending on the type and complexity of the assignment and used scanning techniques when reading Web texts, as well as close reading. However, they also frequently overlooked right answers or relevant texts. Evaluating Web information only occurred with a view to determining the usefulness of a site and not a website's reliability. The **adequacy of the students' strategies** showed great differences both between and within assignments.

With regard to the specific **characteristics of students' (in)adequate Web strategies**, we first looked at the Web searching, reading and evaluating skills that students showed during the assignments. Our study shows a mixed picture of students' use of these skills. With regard to their **Web searching skills**, students in general knew how to use Google, but they were not always able to compose relevant keywords. The students sometimes made spelling mistakes, especially with regard to simple words. With regard to **Web reading skills**, all students were able to use Web text elements such as menus and links. Most students appeared to be quite able to locate information on a website when they knew the information must be there. However, they easily overlooked relevant information, or looked for information on a totally irrelevant website when they had to find relevant websites themselves. The students' use of **Web evaluating skills** showed that they were aware of the importance of such skills and were able to identify the main purpose of a website and to critically question a website's reliability. However, they did not use this knowledge when using the Web for their own information need. Although they sometimes assessed the usefulness of a specific website for finding the required information, they never questioned a website's reliability or trustworthiness.

The students' Web literacy skills did not offer sufficient insight into their ability to use the Web adequately, which was illustrated by many students' inconsistent Web behavior. We identified four patterns that underlie the students' (in)adequate

Web use. First, flexibility, that is, being able to alternate Web strategies, appears to affect students' adequacy positively. Secondly, impulsiveness seems to be related to inadequate use of Web strategies, and may be contrasted with the patience required when using the Web. The students' general tendency to primarily focus on finding the exact right answer, instead of looking for bits and pieces of information from which they could compose the answer themselves, also contributed to inadequate Web use. Finally, a more general quality of adequate Web strategy use is reflection on one's search process. Reflective use of Web literacy skills seems to determine students' adequate Web use. Reflection may, for example, involve keeping in mind one's information need and relating the obtained information to that need. These were aspects of Web use that most students in our study did not practice as a matter of course. Their motives for preferring the Web to books were related to (what they perceived as) the speed and convenience of the Web. In other words, most students did not regard their Web use as being in need of reflection. This poses a challenge for educators and librarians who want to teach students how they can use the Web for knowledge construction.

Our study confirms other recent research on students' Web use in several ways. Students' lack of evaluating behavior is mentioned in several studies (e.g., Shenton & Dixon, 2003; Kuiper, Volman & Terwel, 2005). Todd (2006) also mentions students' strong orientation towards the gathering of facts. Interestingly, our study shows a different type of student behavior than the interview-based study by Enochsson (2005) into students' own perspectives on possibilities and difficulties with regard to Web use. The students in her study appeared to be aware of the specific skills needed on the Web, including language related skills such as spelling correctly, and critical evaluating skills. Especially the older students also mentioned the time it takes to become a skilful Web user. In our study, many students were of the opinion that they were already rather good Web users. However, this was only partly reflected in their actual Web use. Enochsson's study took place in the years 1998 to 2003. In most developed countries, students' use of the Web both at home and at school has increased considerably in recent years. This may have influenced their perception of their own Web skills.

Our study only differentiated between students with regard to reading comprehension. In a study on somewhat older students, Heinstrom (2006) mentions different information seeking behaviors of students with different study approaches, i.e. surface, deep and strategic approaches. Most students in our study seem to be using a surface approach, which may also be due to the task they had to perform: although almost all students were motivated to complete the assignments, the tasks

itself were factual and not particularly inviting to use a more strategic approach. It would be worthwhile to use a similar approach to the study of Web behavior with students working on more inquiry-like assignments.

What are the implications of our results for educational practice? First of all, educators should be attentive to the impact of using an originally non-educational tool in the classroom. It is not enough to look at the Web as merely a replacement of print information resources. The use of the Web must fit in with learning goals. For example, using the Web to learn specific, prescribed knowledge of the digestive system may require a different use of the Web to students' writing a paper on a self-chosen aspect of that digestive system. Secondly, already in the lower grades, students must be introduced to the skills needed when using the Web for knowledge construction. The students who participated in our study were 10 to 11 years old; most of them were already experienced Web users at home. This affected their opinions on the need to learn new skills or to modify their existing skills. Therefore, the school needs to deal with Web use already in earlier school years, when students have not yet fully developed their own Web using habits.

The use of the Web in education poses a dilemma for teachers who want to motivate their students and fit their teaching in with students' preference for using the Web instead of print resources. Such preference is partly based on the Web's supposed speed and ease of use, which is at odds with using Web information reflectively and critically. Moreover, students use the Web even more at home than at school. It might be that their ways of using the Web at home do not fit in with what is expected at school. In the classroom, students are expected to use information resources for the construction of knowledge and to feel responsibility for their own learning. Students' view of the Web as an easy way to find a readymade answer is reflected in their impulsiveness and impatience when they do not find the required information quickly enough. Also, students' extensive use of 'trial and error' methods reflects their habits when using the Web in their own homes. Trying out several strategies is much more common than reading carefully and then deciding what to do first. On the Web, such a strategy may in fact be very useful, because there rarely is only 'one best way'. When using the Web for educational purposes, this lack of a single best way may conflict with a teacher's need for control of the ways students use the Web and of the results of their information seeking.

At home, students do not learn critical reading and reflective skills naturally. They need others to show them the need for such skills and to learn their specific use. At school, these skills are already part of the literacy curriculum but mostly with respect to conventional reading resources only. In fact, most students learn such

skills from print-based methods and do not apply them when using the Web as a matter of course. In our view, a more substantial part of the literacy curriculum should be devoted to new, less print-based information resources. In addition, reflective skills as well as the ability to make well-founded choices and decisions may become more important in the current information society and will consequently have to be discussed and learned at school. In this light, the task for education may not lie primarily in teaching students Web searching skills, but in showing students the need for learning and practicing specific Web reading skills and Web evaluating skills, as well as a reflective use of these skills.

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Appendix 1: Content of the two programs

Searching for Web information

In general: introduction of various Web searching strategies, their possibilities and limitations, and the specific skills required

- Google: inferring search terms from the assignment or question; correct spelling of search terms; restricting one's searching to Dutch sites; composing searching terms; paying attention to the amount of Google's results; the way Google 'works'.
- Search engines different from Google
- Searching with a specific URL: composition and spelling of URL's
- Directory page: purpose and structure of directory pages
- Children's search engine: advantages and disadvantages of specific search engines for children
- Searching options within a specific website: composing of search terms; need for correct spelling

Reading Web information

In general: introduction of differences between the structure of print and Web texts; specific Web reading strategies as well as reading skills required on the Web

- Scanning search engine results (using keywords)
- Reading text on a website literally
- Scanning text on a website (using keywords, headings); knowing the various ways websites are constructed
- Using website menus; knowing the meaning and function of a menu
- Using website links; knowing the meaning and function of links

Evaluating Web information

In general: introduction of the need for Web evaluation; components of Web evaluation; strategies to determine the reliability of websites as well as the skills required

- Evaluating one's understanding of Web information: paying attention to the difficulty of specific Web information and the relation to previously acquired knowledge
- Evaluating the reliability/authority of Web information: paying attention to who has constructed a particular website; paying attention to the purpose or intention of a website; paying attention to the function and meaning of non-textual elements, especially images
- Evaluating the usefulness of Web information: paying attention to the relevance of information for one's information needs

Appendix 2: Web assignments

Assignment 1: Web literacy skills: integrated use of Web searching, reading and evaluating skills (free Web search – one correct answer)

Search the Web to find an answer to the question: "Which language do the inhabitants of the island of Madagascar speak?" You may search the Web in your own way!

Assignment 2: Web literacy skills: integrated use of Web searching, reading and evaluating skills (free Web search – one right answer)

Search the Web to find an answer to the following question: "At the end of each year the *Algemeen Dagblad* daily newspaper wants to find out where in the Netherlands they sell the best doughnuts. Which doughnut bakery in which town made the best doughnuts in December 2004?" You may search the Web in your own way!

Assignment 3: Web literacy skills: primarily Web reading skills (specific website – one correct answer)

Open the website of Queen Beatrix and her family: `www.koninklijkhuis.nl`. Search on that website for the answer to the following question: "What are the names of the children of Princess Margriet's oldest son (one of Queen Beatrix's sisters)?"

Assignment 4: Web literacy skills: Web reading skills and forming one's opinion about a website (specific website – arguments, more than one correct answer)

Examine the website of the society for the prevention of cruelty to animals (`www.dierenbescherming.nl`). Then write a short evaluation of the website: write as many things you appreciate about the website and as many things you do not appreciate. Think of all the things you must take into account when you examine and read a website!

Assignment 5: Web literacy skills: Web reading skills and one specific aspect of Web evaluation, i.e. determining the main purpose of a website (Specific website – arguments, more than one correct answer possible)

Open the website `www.waddenvereniging.nl`. Examine the website carefully. Then answer the following question: "Why has the Waddenvereniging constructed this website?" *Write your answer down as completely as possible!*

Assignment 6: Web literacy skills: Web reading skills and one specific aspect of Web evaluation, i.e. determining the usefulness of a website (specific website – arguments, more than one correct answer)

Open the website `www.kinderconsument.nl`. Examine the website carefully. Then answer the following question: "Do you think this website is useful to children? *Write your answer down as completely as possible!*

Appendix 3: Example of a transcript of Camtasia screen and audio recording

Students' conversation	Students' screen activities
S1: let's see, what must we do. Just type in Madagascar, for a try. S2: How do I spell that?	
(S1 spells Madagascar)	S2 begins to type
S1: Yes like that	S2 types in Madagascar in Google's search box They click on Google search They very quickly scan the first Google results
S1: Maybe this one	
S2: That one?	S2 points with the mouse on an index page about Madagascar
S2: No, those are pages with all sorts of links and so on	S2 still opens this page
S1: O that one, that one underneath that one (she sees a link written in English) S2: Why? There it says…	They go back to Google's search results
S1: You must do pages in Dutch	
S2: Okay Shall I click on Google Search?	S2 clicks on Google's homepage at 'search in Dutch'
S1: Yes	S2 clicks on the Google Search box
That one, yes this one!	S1 reads the text on one of the first Google results S2 clicks on the link , maximizes the screen and scrolls down
S2: Umm, about the language…	Both students scan the text
S1: No wait, it's up there	S1 sees the website's menu with 'Language' as one of the options and clicks on the link. Both students scan the text quickly, looking for a heading about the language on Madagascar and find it without any problem.

Appendix 4: Summarized coding form used for the analysis of assignments 1, 2 and 3

The form is used in order to assess the adequacy of students' searching and reading activities within the context of that specific assignment.
An activity is seen as a distinct action on the screen. Talking about an activity is not counted as an activity unless talking leads to action. Activities may concern three aspects of students' Web behaviour:

- T = typing a word or a couple of words
- C = clicking on a search result or a link, menu or option
- R = reading activity; reading may refer to reading a specific Web text as well as reading a list of search results. Assessing a reading activity takes both the students' screen behaviour and their conversation into account.

All activities receive the score 0, 0.5 or 1, depending on the adequacy (or relevance) of that activity in the context of a specific assignment.

- 0 The activity is irrelevant for completing the assignment and does not contribute to finding the right answer; this category also contains 'non-actions' such as skipping a relevant text on a website in which the answer may be found
- 0.5 The activity is somewhat relevant for completing the assignment, it might contribute to finding the right answer.
- 1 The activity is relevant for completing the assignment, it does contribute to finding the right answer

Examples (of coding for assignment 1: "Which language is spoken by inhabitants of the island Madagascar?")

T 0 Typing 'language' in Google's search box
T 0.5 Typing 'Madagascar' in Google's search box
T 1 Typing 'language Madagascar' in Google's search box

C 0 Clicking on a search result that has no reference to Madagascar in its heading or accompanying text
C 0.5 Clicking on a search result that has some reference to Madagascar in either heading or text, but has no reference to language spoken on Madagascar
C 1 Clicking on a search result that refers to both Madagascar and language spoken on Madagascar in heading or text

R 0 Scrolling on or reading a particular Web text that contains the answer on the question, but failing to see that answer (e.g., because students read too fast); looking for the answer on a website that does not refer to Madagascar
R 0.5 Scrolling on a particular website with the question in mind, but absent-mindedly, which may be reflected in students' actions and talking (e.g., "we must look for headings about the language they speak" while scrolling too fast to really read anything)
R 1 Scrolling on a relevant website or reading a relevant Web text clearly with the question in mind, which may be reflected in the way students talk while reading (e.g., "we must look for a heading about the language they speak")

Conclusions

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The Web is increasingly used as an information resource by students in primary education. Most students prefer to use the Web instead of books because they like using the computer in general and the Web's accessibility and supposed user-friendliness in particular. Teachers, however, often question the learning gains of Web use by students. In this thesis, we addressed the potential use of the Web as a tool for knowledge building in the upper grades of primary education. In the introduction, we formulated the following general research problem:

> How can students be supported in using the Web for knowledge building?

The study of the Web as a new information tool may be situated within recent educational theories on the construction of knowledge in the current information society. Rather than on accessing information, the focus needs to be on creating personally meaningful knowledge with the help of that information. In addition, other disciplines such as the Library and Information Science and reading research, communication research and educational research in general can contribute to our understanding of the ways students can be supported while using the Web for knowledge construction.

We approached our general research problem in two ways. For part I of the thesis, a multidisciplinary literature study was conducted to answer our first research question:

> What skills do students need when using the Web for knowledge building?

Part II of the thesis contains the empirical part of our research, which addressed our second research question:

> How can Web literacy skills be learned within the context of an educational program and what are the learning results of such a program?

From the literature study, key elements were derived for the design of two programs aimed at teaching 5th grade primary school students Web searching, reading and evaluating skills within the context of a project on healthy food. The programs were implemented by four schools and evaluated separately with respect to the way teachers worked with the program, as well as contextual factors that influenced its realization and students' learning results. In the penultimate chapter, we returned to our first research question on the basis of empirical data on students' post-program Web use, readdressing the skills students need to be able to use the Web for knowledge construction.

In this concluding chapter, we summarize and integrate the findings from both research parts and discuss the implications for the general research problem. We also reconsider the evaluations of the two programs with respect to their differences and

similarities. In conclusion, we discuss the implications of our research for educational practice and indicate suggestions for further research.

1_ Conclusions

1.1 What skills do students need when using the Web for knowledge building?

The literature study explored the following two research questions:

- What are the characteristics of children's Web-search behavior, and what problems do they encounter?
- Which characteristics of the Web should be taken into account when using it in education?

Interaction between information resources and their users is a common research topic in Library and Information Science (LIS) research. As a result, most research into children's Web use is found in that discipline. In addition, also some educational research focuses on Web use (particularly) in science education. The literature taught us that many children appear to have difficulties in locating relevant Web information. They lack searching skills as well as the necessary skills to use the information effectively when they find it. Children also rarely take into account the relevance, reliability and authority of the information they find. They either do not wonder about the 'authority' of the Web, or do not know how to evaluate Web information on its reliability. Students hardly ever explore on the Web. Rather, they tend to stay focused on finding a single correct right answer. Some gender differences are found, especially with regard to time spent on Web reading and formulating key words when searching the Web. Task characteristics appear to influence both Web search processes and their results, although research results are not uniform with regard to the direction and extent of such influence.

Especially the more theoretical literature with a critical-pedagogical approach as well as reading research and new media research have been useful when we addressed the second research question. From these sources we derived four major Web characteristics that have consequences for education. The size and topicality of the Web implies access to a vast amount of information for students. This also means that students, first of all, have to know exactly what they are looking for and, in addition, that they must have effective searching skills to find what they are looking for. The accessibility of the Web implies that students have easy access to a great deal of information and may easily produce Web information themselves. However, they may also easily be confronted with erroneous, useless or harmful information. Children need to learn to cope with such negative sides to the Web,

while having to develop the necessary competences to use the Web critically. The use of hypertext makes high demands on specific Web reading skills, such as using links and other navigational clues. Assessing the reliability of Web texts is also important. Finally, the visual (or multimodal) character of the Web makes it necessary for students to learn to 'read' such visual information and to learn to judge the visual information with regard to functionality, meaning and how it relates to the text.

The literature study also provided indications as to how students could acquire the necessary skills. On the whole, embedding the teaching of Web skills within the context of a content knowledge domain is preferred. In this way, the pitfall of students learning isolated skills without a context and without any need to use those skills can be avoided. An inquiry-oriented curriculum, in particular, could be a valuable context for acquiring Web skills, since students are asked to use these skills for meaningful activities. This fits in well with recent educational theories which emphasize the importance of active construction of meaningful knowledge.

1.2 Evaluation of two programs for teaching students Web literacy skills

From the literature findings, we derived indications for the content and design of two learning environments in which the acquisition of Web skills was incorporated into the learning context concerning a specific content knowledge domain, a program on the subject of 'healthy food'. We arranged the Web skills into three categories: Web searching skills, Web reading skills and Web evaluating skills. The term 'Web literacy' was used as an umbrella concept under which the three categories were organized. One program used a structured and sequential approach and focused on the students working actively and independently. The other program integrated the teaching and learning of Web literacy skills with the students' collaborative inquiry activities. Both programs had the same learning goals, the acquisition of Web literacy skills and content knowledge on the subject of healthy food. The sequential program combined elements of active and self-directed learning with more traditional, teacher-directed ways of teaching. However, the inquiry-based program fitted in best with the recommendations on teaching Web literacy skills which we derived from the literature study. Therefore, we wanted to investigate whether such a program is, in fact, an appropriate way to teach such skills.

Both programs were implemented in four 5th grade school classes. The use of a multiple case study design and a variety of data sources, allowed us to evaluate both programs with regard to the following research questions:

- How did the teachers and students give shape to the program and how did contextual factors influence the realization of the program's intentions?
- What were students' learning results in terms of Web literacy skills and content knowledge?

We reported on both programs separately in the chapters 2 and 3. Here, we want to reconsider and compare the implementation and results of both programs, with a view to the question

- How can Web literacy skills be learned within the context of an educational program?

Design and implementation

With respect to the **sequential program**, all teachers were able to work fairly well with the program they were asked to follow. There appeared to be four groups of contextual factors that influenced the program's realization: the teacher's investment of time and effort; the teacher's use of teaching strategies such as class discussions; practical circumstances such as the lay out of computers in the school building; and specific class conditions such as class atmosphere. One essential factor appeared to be the existence of a correspondence between teaching style and the program's assumptions. Teachers who were able and willing to combine elements such as class discussion and students' working in pairs with the teaching methods they were used to, received greater satisfaction from the project and inspired motivation on the students' side.

In the **inquiry-based program**, these contextual factors also played a role. However, both class atmosphere and the teachers' teaching style appeared to be more influential in this program than in the cursory program. The inquiry-based program was designed as a collaborative project in which students together produced an information brochure about healthy food for their fellow students, based on their own research questions. A class atmosphere in which the conditions for working collaboratively were present, resulted in students sharing both knowledge and responsibility for the making of the brochure together. Also, students' learning depended on the way the teacher interwove the necessary Web skills with the students' information searching process. The teacher who succeeded in making such a connection provided more learning opportunities for students. Other relevant factors that influenced the project's course and results concerned the composition and content of students' research questions and the students' basic inquiry skills, which illustrates the complexity of the inquiry-based program for both teachers and students.

When comparing the ways the teachers carried out both programs, it is striking that in both programs the teachers' teaching style and its correspondence with the project's assumptions and layout appeared to influence the way the programs were

realized. We expected this to affect the inquiry-based program, since this program appealed to specific teaching skills and was less laid out in advance. The students' own research questions determined the precise way the project evolved, and, consequently, the teacher had to be able to accommodate the project's lessons to both the students' questions and the Web content they brought up. In the sequential program we had expected fewer differences between the ways the four teachers worked with the program, since these teachers were used to work with structured and prescriptive methods.

The intended added value of teaching the skills in an integrated way and related to content knowledge was not fully recognized by all of the teachers. All teachers were of the opinion that the program required a great deal of time and effort. The teachers of the sequential program suggested that the program be split up to be able to deal with the separate Web skills in separate projects or units. The teachers of the inquiry-based program suggested that the content of the project be spread out over several smaller projects during a school year, every project building upon the Web skills learned in the previous project without disconnection. Especially the embedding of Web literacy within a content knowledge domain deserves attention, in our opinion. Although the programs aimed at a balance between teaching Web literacy skills and content knowledge, in the layout of both programs the emphasis of the learning goals was on Web literacy skills. As a consequence, especially in the sequential program, both teachers and students regarded the project's theme partly as 'decoration'; useful in itself but not really necessary for acquiring Web literacy skills. In the inquiry-based program, content came much more to the fore because of the students' research questions and brochure composition. In this program, the teachers sometimes had difficulties paying enough attention to the acquisition of Web literacy skills. This illustrates the difficulties related to connecting learning to use a complex tool such as the Web with acquiring knowledge of content matter, as preferred in the literature. When the latter is the most prominent learning goal, it is much more useful to make a selection of relevant websites instead of letting students search for information themselves. However, if learning critical Web use is the most prominent learning goal, students should be made to encounter difficult aspects of Web use such as abundance of information and dubious authority.

Students' learning results

Did the programs succeed in teaching students Web literacy skills and content knowledge of healthy food? Our results showed that all classes in both programs showed knowledge gain with respect to the subject of healthy food, and all classes but one in the inquiry-based program showed knowledge gain with respect to Web literacy skills. Does this also mean that both programs are sufficient for teaching

Web literacy skills? In the preceding chapters 2 and 3, we reported on students' learning in each program. Our conclusions were more or less the same in both chapters: students had gained knowledge of aspects of Web literacy skills, but their actual use of the Web in the final assignments after the projects also showed deficits. Also, many students seemed to be able to use Web searching, reading and evaluating skills but did not do so consistently. Although, generally speaking, the weaker reading students performed less adequately on the assignments, strong students also showed unexpectedly inadequate Web skills and strategies.

Both within and between the programs, populations differed with respect to ethnic and socioeconomic backgrounds and mean reading comprehension scores. For example, one class in the sequential program, in particular, had many students from non-Dutch backgrounds, with serious reading and language problems, while in the inquiry-based classes, the reading levels of two of the four classes were exceptionally high. Although as a consequence classes as well as programs are not easily compared, all classes together showed us a variety of students. This enabled us to obtain a good picture of their performances. In chapter 4, we decided to focus on a selection of students from all participating classes together, to have a closer look at their use of Web literacy skills and strategies after the programs. With respect to the characteristics of the students' (in)adequate Web strategy use, we studied the students' use of the Web in greater detail during six post-program assignments. This provided additional information with a view to program improvement.

We identified four patterns underlying students' (in)adequate Web use. Flexibility, that is, being able to alternate Web strategies, appeared to promote students' adequacy. Many students showed a tendency to 'rely on Google' in finding the right answer for them, which contributed to an inflexible use of Web strategies. Impulsiveness was related to an inadequate use of Web strategies - as opposed to patience - when using the Web. The students tended to be primarily focused on finding the right answer on the Web, and hardly resorted to exploration in order to compose the answers themselves, which also contributed to inadequate Web use. A more general quality of adequate Web strategy use was reflection on the information seeking process, e.g., relating the Web results found to the task at hand or adapting the search process when results stay out. Overall, the reflective use of Web literacy skills seemed to determine the adequacy of the students' Web use.

These patterns are not necessarily related to Web use and might partly be associated with general inquiry skills. They do, however, interact with characteristics of the Web. The Web, offering an abundance of easily accessible, unauthorized and unrelated bits and pieces of information, preeminently demands flexibility, patience,and reflection from its users, apart from specific searching, reading and

evaluating skills. As a result, teaching and learning to use the Web in critical ways, with a view to knowledge construction, requires that the specific skills the Web demands from its users, such as finding one's way through large amounts of unordered and unauthorized information are explicitly related to the described patterns. With respect to specific Web literacy skills, Web reading skills as well as general reading skills appeared to be more influential than expected on the basis of the literature study reported in chapter 1. There, we pointed to Web searching and evaluating skills as being the most prominent aspect of effective Web use. The importance of reading skills is confirmed by recent research on Web reading by Coiro & Dobler (in press), who analyzed in detail what reading activities were performed by 6th grade high ability students. The Web appeared to appeal to sophisticated and complicated Web reading skills and strategies, which partly differed from general reading skills and strategies.

In both programs, there seemed to be no direct relation between the way the teacher carried out the project and students' learning results in terms of knowledge of healthy food and Web skills. With regard to the sequential program, this may be a consequence of the way the teaching materials were designed: at least to some extent, the structured and prescribed content provided equal learning opportunities. In the inquiry-based program on the other hand, the teacher's view and interpretation of the project were expected to be more critical for students' learning. Although the class in which the program's intentions were achieved to the highest degree, in fact, showed considerable knowledge gains with regard to both knowledge of healthy food and Web literacy skills, in two other classes these knowledge gains also became significant. However, this class showed an understanding of the need to acquire Web literacy skills for their own questions and purpose, i.e. in order to be able to make an informative and reliable brochure. In other words, the intended added value of the inquiry-based program was best realized in this class, which may be related to the way the teacher implemented the program.

Correspondence between the programs' intentions and their realization

In both programs, we aimed at teaching Web literacy skills in an integrated way, within the context of a content knowledge domain, the subject of 'healthy food'. To what extent did the programs succeed in meeting these intentions? The intended integration of the various Web skills was most prominent in the inquiry-based program, presumably because the learning of these skills was embedded in the students' own information seeking, in which all Web skills came together quite naturally. The challenge for the teachers was to temporarily decompose and discuss these skills and

then reintegrate them with a view to the students' inquiry activities, as well as to bring up and reflect on such skills 'exactly at the right time '. In the sequential program, the various Web skills were initially dealt with one after the other, whereupon they were incorporated into assignments in which students had to apply the learned skills. We assumed that by providing a context of a content knowledge domain, Web skills might easier get meaning for students. In the sequential program, the context consisted of a common theme for all lessons and the opportunity to learn about aspects of healthy food while making the exercises. In the inquiry-based program, contextualization was more prominent: the Web literacy skills were dealt with and practiced on the basis of students' own searches for relevant information in relation to their research question, with a view to making an informative brochure on healthy food. The surplus value of the contextualization is illustrated clearly by students of one inquiry-based class in particular, who explicitly expressed their need to learn to use the Web in a critical way because otherwise they were not able to put together a reliable and informative brochure. Precisely this element may be the distinguishing factor between the two programs in our study: differences depended on insights into the necessity and functionality of those skills rather than on the learned skills themselves.

2_ Discussion

2.1 Implications for educational practice

Our research shows that students do need support when using the Web for knowledge construction and confirms the importance of paying attention to Web literacy skills. The support provided in our programs was partially effective, especially with respect to students gaining knowledge of the necessary Web skills and strategies. However, students still showed many instances of inadequate Web use after the project and thus did not act upon their acquired knowledge. Our focus on Web literacy as consisting of skills in Web searching, reading and evaluating, which was initially based on our literature study, appeared to be applicable in the translation of these skills to educational program components. However, our empirical study indicated two important suggestions for modification of the programs, namely the importance of paying attention to the quality of students' Web strategy use as well as to general reading skills. Qualities such as reflection, flexibility and patience, together with (general and specific Web) reading skills, seem to be a necessary condition for using the Web for knowledge construction. Furthermore, learning these skills in the context of collaborative inquiry activities such as the inquiry-based program in our research is necessary to allow the students to gain

insight into the need for such skills for their own questions, purposes or information searches.

As a consequence, one implication for educational practice lies in the domain of **reading education**. Reading has always been a basic skill in all school curricula, but the use of the Web as a reading resource partly requires different and new reading skills. This has consequences for the design of reading comprehension methods, which currently are primarily focused on reading print resources. Although they often pay some attention to the Web and its specific characteristics, the methods used are print-based and thus unable to address Web reading proper. Children do not learn critical Web reading from books. Moreover, children increasingly use Web-based information instead of print information; methods restricted to the reading of print-based texts do not fit in with children's own information behavior. In most reading comprehension methods, there are many exercises in which students receive a text and a series of questions about that text. They are requested to read the text carefully and answer the questions. Through such exercises, students learn to find answers in a text they know these answers can be found. But such a method fails to prepare students for use of the Web as a knowledge resource. In this respect, the **Herziene kerndoelen basisonderwijs** [renewed primary school core targets] (SLO, 2006) unintentionally illustrates how curriculum developers and policy makers view the preparation of students for Web use in education. **Kerndoel 6** of the **Kerndoelen Nederlandse taal – schriftelijk onderwijs** says:

> "Students learn to order information and opinions by reading school and study texts and other instructive texts, as well as through *systematically organized sources, including digital sources*." (italics by author)[22]

It may be clear that, by contrast, the Web is anything but 'systematically organized'. We suggest that reading methods should take Web reading seriously and devote time and specific reading methods to the differences between print and Web texts, as well as the specific characteristics of Web reading and exercises to practise specific Web reading skills.

Perhaps not surprisingly, our research revealed that a program of eight to ten weeks is too short for teaching and practising complicated skills like Web literacy skills. We therefore suggest that **more encompassing curricula** or **extended learning programs** be developed in which Web literacy is attended to over longer periods of time, through various grades of primary and secondary education.

[22] "De leerlingen leren informatie en meningen te ordenen bij het lezen van school en studieteksten en andere instructieve teksten, en bij *systematisch geordende bronnen, waaronder digitale bronnen*."

A final implication for education concerns necessary changes to **teacher education curricula**. In our view, teachers do not lose but, rather, gain importance in a Web-based information era. They can support and guide students in giving meaning to information found on the Web, through joint analysis and interpretation with students of the relevance and authority of the information found, and by relating such information to previously acquired knowledge as well as by the modelling of critical Web use. This means that, in teacher education, such student support must be taught. Although student teachers themselves are part of the 'Net-generation', this does not mean they are able to teach such complicated skills as a matter of course. During their training they should be challenged to grow into competent and critical Web users themselves.

In addition to these implications, our research brought two more general issues to the fore that need to be resolved. We will discuss both issues and provide suggestions for possible solutions and/or ways to deal with these issues in education.

First, we address a paradox which we name the '**availability paradox**'. The Web is without doubt a valuable tool for knowledge construction because of the possibility it offers to access primary, current and real-life resources. However, the availability of an abundance of easily accessible information on the Web invites students to think that every answer can be found ready-made. Instead of becoming active knowledge constructors, they expect Google to find all the answers for them with some clicks of the mouse. Thus, the potential of the Web as an educational tool may turn into a trap. Recently, Vincent Icke (2006) named the Web an 'open sewer' which invites students to collect isolated facts while being incapable of connecting and integrating those facts, or of evaluating their value and authority. In Icke's view, students no longer acquire the necessary knowledge of both facts and inquiry methods at school. In our view, students' lack of research skills and their tendency to expect the Web to find the right answer for them reflect the tasks and questions they meet at school. When school tasks come down to 'finding the right answer', students are used to interpret tasks in such terms. However, such emphasis reinforces a rather superficial and narrow way of dealing with Web information.

In our view, the paradox can only be resolved by dealing with students as active and responsible learners instead of passive acquirers of knowledge. Students have to be challenged to become active knowledge constructors, which requires explicit teacher support. The teacher must set standards for what counts as 'knowledge' and must question the difference between knowledge and information together with the students. Students' general inquiry skills need to be developed in order to use the Web for knowledge construction. However, most students do not develop such skills

as a matter of course, and certainly not during an era in which the gathering of information has, on the face of it, never been easier. This means that these skills must be seen as basic, requiring constant attention through education. In our 'information society', learning to reflect on and make sense of information has become an essential skill.

The second, partly related, issue concerns the dilemma of the educational use of an out-of-school tool. Most students like to work with computers at school, and the Web undoubtedly holds a special attraction for them. However, the computer is a learning tool that differs from other tools used in education. Students not only use both the computer in general and the Web more out of school than at school, they also acquire a great number of Web skills in out-of-school contexts, and regard themselves as skilled Web users. Yet, their skills do not always fit in with the school's expectations. Because most students learn to use the Web outside school, they seem to learn other Web skills than the skills expected at school. They are quite able to use the Web for their information seeking in their own daily lives, but lack the more academic information and inquiry skills that are necessary for using the Web in the construction of academic knowledge. Conversely, the way the Web is used at school often does not fit in with the students' likes and dislikes. When the Web is introduced as something involving skills that one has not mastered yet it becomes something 'bookish' to many students, a device that does not have anything to do with the way they use the Web themselves.

This may be illustrated by the research findings of Burnett and Wilkinson (2005), who report on a study in which the focus was on comparing the Web behavior of children at home and at school. Their findings suggest that students are more capable of using the Web at home than at school. One explanation may be that use of the Web as an information resource at home differs from Web use at school. At home, students use the Web mostly for the type of information need that is closely related to their everyday lives, for example when searching for information about the latest cell phones to buy. Research by Stone (2006) shows that even low performing students are capable of quite sophisticated Web reading when using the Web in their free time. Students who were classified as bad readers at school, quite effortlessly read complicated websites about hiphop music, using difficult language. Thus, not only information goals but motivation as well seem to influence students' performance. This does not necessarily mean that teachers must incorporate websites about hiphop in their curriculum. As is illustrated in research about students' use of ICT outside school, students distrust such use of popular culture elements in education (Guzzetti & Gamboa, 2004). It does, however, mean that teachers must be aware of

their students' use of the Web outside school, and the skills they possess and show in daily life.

We do not have a ready-made solutions for this phenomenon. However, it is clear that teachers and researchers have to take its consequences into account. In our opinion, more connections should be created between students' in-school and out-of-school Web activities. Discussing with students what they do on the Web, what they like and dislike, and what they think of, and expect from, Web use at school would seem to be of the utmost importance. Students' Web skills must be taken seriously, which also means that they must be confronted with the limitations of their skills. However, such limitations should become clear not by telling students what they must learn, but by connecting Web literacy skills such as critical searching, reading and evaluating Web information to their out-of-school information needs. In this connection, our own programs also showed certain limitations. Especially in the inquiry condition, some students looked at the project as something that had nothing to do with their own Web skills and ways of using the Web, since they were used to working with the Web in ways they preferred. By taking them more seriously as participants, in the sense of already possessing valuable skills, a learning environment should be created in which both teachers and students could share knowledge and skills in collaborative activities.

2.2 Suggestions for further research

Our research had the nature of an exploratory case study. Although its results can not be generalized, it offered insight into the ways Web literacy can be taught, the influence of contextual factors on implementation and learning results and the support students need to use the Web for knowledge construction. From our results, we derive suggestions for three lines of further research.

First of all, more research is needed into the various ways Web literacy skills can be taught. The evaluation of our two programs provided insights into both the content and the design of teaching Web literacy skills, but also indicated suggestions for modification. Future research should preferably be of a design-based character, since design-based research gives ample opportunities for studying the development of Web literacy curricula over longer periods of time, in diverse settings.

First, as already mentioned in the previous section, a program of eight to ten weeks appears to be too short to introduce and practice Web literacy skills in sufficiently meaningful ways. Research into the way Web literacy may be taught should therefore also focus on evaluating more extended learning programs in which teaching Web literacy skills is spread out over a longer period of time and these skills are attended to in a more gradual way.. This has consequences for research

design, since more extended learning programs imply the development of students' Web literacy skills over longer periods of time. Research should focus on students of various age groups in both primary and secondary education. It should also take various school and class contexts into account, as was the case in our own research, since such contexts provide useful information about both the workability and contextual conditions that affect the realization of the intentions of such extended learning programs.

Secondly, we suggest that the focus in future research be placed on comparison of programs in which teaching and learning of Web literacy skills is integrated with domains such as reading comprehension or world studies versus programs that exclusively focus on Web literacy skills, as was the case in our research.

Thirdly, our evaluation of the inquiry-based program showed the significance of working collaboratively towards a goal that gives meaning to the learning and practising of Web literacy skills. In such a way, learning the necessary skills for accessing, reading and evaluating Web information may become meaningful in that students are asked to apply the information in order to become authors of useful information themselves. There may be other valuable ways of embedding the learning of Web skills within inquiry activities, for example by letting students construct data bases with reliable and useful websites on certain subjects for the benefit of other students. Both the development and evaluation of such alternatives in practice-based research may be useful.

Finally, future research into acquiring Web literacy skills within inquiry activities should involve teachers in both development and evaluation to a greater extent than was the case in our research. Teachers' knowledge and experience is of great value in view of the essential role of the teacher with regard to the success of programs designed in such a way.

More educational research is also needed into **the ways students acquire Web literacy skills both inside and outside school settings**. (Descriptive) research of Web use of the same student group inside and outside the school context may be useful for reflecting on and exploring the findings of Burnett & Wilkinson (2005) regarding students' different uses of Web skills in both contexts. We also suggest that attention be devoted in future research to longitudinal research of same groups of students with regard to their Web use in and outside school and in relation to Web literacy skills curriculum development. Whether children and teenagers are labeled positively as the Einstein or more negatively as the copy-paste generation (see also the General introduction), they acquire many Web skills outside school. Although our research indicates the specific task of education with regard to the acquisition of critical Web

skills, more research is needed to formulate more precisely what in fact children know about the Web and which skills and competencies they already possess, on order to define the potential added value of education.

Finally, research into differences between students in Web use has been rare to date. Future research should consequently focus on these differences, for example, with regard to the question of how weak readers can be supported in their Web use. Our research indicates that such students, comparatively speaking, have more problems in using the Web as a source of information and knowledge. This may be important for their general achievements in education in that such an ability is generally presupposed in or outside school.

2.3 Some final remarks

Conducting research into children's Web use might appear to be a rather ephemeral affair. After all, paraphrasing our last remark of chapter 1, the Web as well as its users change faster than we can evaluate them. According to the authors of 'De Einstein Generatie', the adolescents who are now between 12 and 18 years already differ considerably from those half a generation above, now in their twenties. Although it might be suggested that this could also be an effect of the different lives students lead at school and at work, technology changes fast and, with the technology, its users. As a consequence, there is no denying that both educational research and practice rather often fall hopelessly behind. When the college teacher has finally mastered the technique of using Blackboard in his or her teaching, the students will, more likely than not, regard such an electronic learning environment as laughably outdated and boring because it uses e-mail instead of instant messaging techniques.

All this means that one has to be rather modest when reporting on the best ways to support students' use of the Web in education. However, it does not mean that students should be regarded as a new, smart and all-knowing generation that teachers and researchers can only admiringly gaze up to, without any hope of ever catching up. A recent publication by Veen and Vrakking (2006) argues that the present student generation possesses certain sophisticated skills that teachers and researchers have to take into account. However, we think this is only one side of the picture. New technologies and new generations of technology users do indeed offer new opportunities for learning. But these new opportunities also necessitate thinking about what counts as 'learning'. For example, to what extent do new information tools such as the Web contribute to or facilitate what we see as learning, and to what extent to they stand in the way of learning? And what is the relation between formal and informal learning in times during which the boundaries between these

two forms of learning may become more and more blurred? Although being of a theoretical nature, these questions also need to be addressed by educational research.

We wish to add to this that the term 'digital divide' might not necessarily lose its meaning during times when the popular impression is that all children are fluent technology users. In fact, such a digital divide may in the future concern differences with regard to the ability to use the Web for one's own information need or 'empowerment' rather than by means of access to the Web or the possession of the instrumental skills to use it. Under the title of **'Mediawijsheid. De ontwikkeling van nieuw burgerschap'**, [Media wisdom. The development of a new citizenship] the **Raad voor Cultuur** [Council for Culture] in 2005 published advice on the importance of specific media and information skills as necessary conditions for good citizenship in the information society, arguing that companies and institutions including the government increasingly expect citizens to be able to use media such as the Web. This means that at school the focus should not only be on academic skills but also on the relationship between critical Web use and citizenship.

During our research we realized the extent to which the boundaries between students' lives in school and out-of-school have become blurred. The Web is and can be used anywhere and everywhere. Being an information resource for schoolwork, it can easily be used and accessed at home. At the same time, the boundaries between authorized and unauthorized information have also become blurred because the Web contains both, which makes it fundamentally different from library-based resources. The subject of our programs, healthy food, showed this very well. Students who searched on Google with the search term **'gezonde voeding'**, were confronted with a mix of websites: among the first ten results, there were websites of the **Voedingscentrum** and the **Hartstichting**, a website about Herbalife, a dietician's website, as well as the websites of Liga, the biscuit firm, and Becel, the margarine maker. On the one hand, this illustrates the added value the Web has to offer. The mixture of all sorts of information on the Web is very suitable when studying real-life subjects with children. A search in the children's department of the local library would at most produce a small selection of informative books. On the other hand, there is obvious confusion about the authority of the information obtained as well as the question of what information can be used for what purposes.

Is the Internet, then, an opportunity or a risk? In the General introduction, we showed various opinions on this apparent dichotomy. In fact, we would argue that the Internet is both. The Internet may offer children new, positive and stimulating opportunities for communication and self-expression, but it may, at the same time, threaten children's well-being through online bullying or sexual harassment.

Similarly, the use of the Web in education can offer great opportunities for learning from primary sources, both current and interactive. On the downside, by inviting students to search instead of re-search, the Web can also be a threat to learning.

In conclusion, it is clear that students of this digital generation can easily find their way on the Web. What they need is support and encouragement in the area that has always been the true core of education: turning information into personally relevant knowledge and insights.

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In Dutch

Samenvatting

Dit proefschrift richt zich op het gebruik van internet in de bovenbouw van het basisonderwijs, en met name op de manier waarop leerlingen kunnen leren om kritisch met internet als informatiebron om te gaan. Buiten school wordt internet veel gebruikt door kinderen en jongeren, voor een groot aantal doeleinden. Kinderen msn-en, surfen, luisteren naar en downloaden muziek, zoeken informatie en plaatjes voor een werkstuk en spelen spelletjes. Ook in het basisonderwijs wordt internet veel gebruikt, met name in de bovenbouw ten behoeve van het zoeken naar informatie voor een opdracht, spreekbeurt of werkstuk. Veel leerkrachten ervaren het gebruik van internet in de klas echter als lastig: ze weten niet goed hoe ze leerlingen moeten begeleiden, en hebben de indruk dat leerlingen weliswaar in staat zijn mooie werkstukken te produceren, maar betwijfelen of ze nu wat van het gebruik van internetinformatie hebben geleerd.

Het onderzoek dat in dit proefschrift beschreven wordt, geeft uitdrukking aan wetenschappelijke aandacht voor het gebruik van internet ten behoeve van kennisconstructie en kan gesitueerd worden in recente onderwijskundige inzichten in de wijze waarop kennis wordt geconstrueerd en in het belang van actief en zelfstandig leren. Met betrekking tot het gebruik van en onderzoek naar internet als informatiebron in het (basis)onderwijs kunnen twee (elkaar niet uisluitende) benaderingen worden onderscheiden. Ten eerste kan internet als leermiddel worden aangepast om het geschikt te maken voor gebruik ten behoeve van kennisconstructie in het onderwijs. Voorbeelden zijn het voorselecteren van geschikte websites rond een bepaald onderwerp of kinderen alleen gebruik laten maken van kinderzoekmachines. Dit proefschrift kiest voor een tweede benadering en richt zich op de vaardigheden van leerlingen om met internet om te gaan en de ondersteuning die het onderwijs kan bieden om die vaardigheden te vergroten. Het richt zich daarbij op leerlingen in de bovenbouw van het basisonderwijs. De centrale probleemstelling van het proefschrift is:

> Hoe kunnen leerlingen worden ondersteund bij het gebruiken van internet ten behoeve van het ontwikkelen van kennis?

Twee vragen geven richting aan het beschreven onderzoek. Ten eerste is er de vraag naar de aard van die ondersteuning, geformuleerd als:

> a. Welke vaardigheden hebben leerlingen nodig om internet te kunnen gebruiken voor het ontwikkelen van kennis?

De tweede deelvraag richt zich op de manier waarop leerlingen kritische internetvaardigheden ofwel ‘Web literacy skills’ kunnen aanleren, en is als volgt geformuleerd:

b. Hoe kunnen 'Web literacy skills' worden geleerd in de context van een onderwijsprogramma en wat zijn de leerresultaten van een dergelijk programma?

Deel I van het proefschrift omvat een literatuurstudie die gericht is op het beantwoorden van de eerste vraag (hoofdstuk 1). Twee deelvragen komen aan de orde die samen leiden tot een antwoord op de eerste onderzoeksvraag:

- Wat zijn de kenmerken van het internetzoekgedrag van kinderen en welke problemen komen zij tegen?
- Met welke specifieke kenmerken van internet moet rekening worden gehouden bij gebruik van internet in het onderwijs?

De literatuurstudie heeft een multidisciplinair perspectief en richt zich op literatuur uit de onderwijswetenschappen, de bibliotheek- en informatiewetenschap, leesonderzoek en kritisch-pedagogische publicaties. Ten behoeve van de eerste deelvraag wordt vooral empirisch onderzoek naar feitelijk zoekgedrag van kinderen besproken. De tweede deelvraag wordt beantwoord met behulp van meer theoretische literatuur over de kenmerken van internet en de eisen die deze stellen aan de vaardigheden van internetgebruikers.

Met betrekking tot het zoekgedrag van kinderen komt uit de literatuur naar voren dat kinderen vaak over onvoldoende zoekvaardigheden beschikken. Ook het verwerken van gevonden informatie is lastig. Daarnaast letten kinderen zelden op de relevantie en betrouwbaarheid van internetinformatie. Als ze zich al bewust zijn van het belang daarvan, weten ze niet hoe ze met name de betrouwbaarheid kunnen beoordelen. Ongeacht de leeftijd, blijken kinderen sterk gericht te zijn op het vinden van een concreet, letterlijk antwoord op hun vraag. Het weinige onderzoek naar verschillen tussen jongens en meisjes laat zien dat meisjes internetinformatie preciezer lezen dan jongens en minder complexe zoektermen formuleren. Taakkenmerken (bijvoorbeeld de mate van openheid van de vraag) blijken veel invloed te hebben op de manier waarop het zoekproces verloopt, al zijn onderzoeksresultaten niet eenduidig wat betreft zowel dat zoekproces zelf als de resultaten ervan.

Er zijn een viertal specifieke kenmerken van internet te onderscheiden die eisen stellen aan de vaardigheden waarover leerlingen moeten beschikken. De omvang en actualiteit van internet biedt leerlingen toegang tot grote hoeveelheden ongestructureerde informatie van allerlei aard. Dat betekent dat zij moeten beschikken over goede zoekvaardigheden om de juiste informatie te kunnen vinden en tevens goed moeten weten waar ze naar zoeken. De toegankelijkheid van internet heeft als keerzijde dat leerlingen eenvoudig geconfronteerd kunnen worden met foutieve, onbruikbare of schadelijke informatie. Leerlingen moeten derhalve leren omgaan met dergelijke negatieve kanten van internet en vaardigheden ontwikkelen

om internetinformatie kritisch te beoordelen. Het gebruik van hypertext stelt leerlingen in staat een eigen weg te vinden op internet, wat echter specifieke leesvaardigheden vereist zoals het goed gebruik kunnen maken van 'links'. Ten slotte maakt het visuele karakter van internet het noodzakelijk om de functie en betekenis van die visuele elementen te kunnen beoordelen in relatie tot de tekst.

De literatuurstudie verschafte een aantal concrete aanbevelingen voor het ondersteunen van leerlingen bij hun internetgebruik. Daarnaast leidde de studie tot de veronderstelling dat het aanleren van bovengenoemde kritische internetvaardigheden bij voorkeur zou moeten plaatsvinden in de context een kennisdomein, en dan bij voorkeur in de vorm van onderzoeksactiviteiten. Op die manier kan worden voorkomen dat leerlingen geïsoleerde vaardigheden verwerven en krijgen leerlingen tevens inzicht in de functie en noodzaak van die vaardigheden.

Deel II van het proefschrift is de weerslag van het empirisch onderzoek naar de tweede deelvraag. In een Inleiding worden twee lesprogramma's beschreven die beide tot doel hadden het leren van kritische internetvaardigheden, ofwel 'Web literacy skills'. Daartoe wordt een onderscheid gemaakt tussen drie categorieën vaardigheden: respectievelijk het zoeken, lezen en beoordelen van internetinformatie. Beide programma's zijn ontworpen als een project over het thema 'gezonde voeding' voor groep 7 van het basisonderwijs. Hoewel de leerdoelen van de programma's vergelijkbaar waren, verschilden ze wat betreft theoretische uitgangspunten en vormgeving op een vijftal dimensies. Het eerste programma is ontworpen als methode om kritische internetvaardigheden binnen een bepaald kennisdomein aan te leren, met vast omschreven lessen en een werkboekje dat voor alle leerlingen gelijk is. De leerkracht heeft als taak om het actief en zelfstandig werken van de leerlingen te begeleiden en stimuleren. Dit programma kan omschreven worden met de noemer 'cursorisch'. Het tweede programma kan beschouwd worden als uitwerking van de theoretische voorkeur geformuleerd in de literatuurstudie; het is gericht op het inbedden van het aanleren van kritische internetvaardigheden in gezamenlijke onderzoeksactiviteiten op basis van eigen onderzoeksvragen van leerlingen. Dit programma noemen we 'onderzoeksgericht'. We wilden onderzoeken in hoeverre het verwerven van kritische internetvaardigheden binnen deze twee varianten mogelijk is.

Bij het ontwerpen van de twee programma's is gestreefd naar vergelijkbaarheid. Het onderzoek naar beide programma's was beschrijvend en explorerend van aard, aangezien er nog weinig empirisch onderzoek is gedaan naar manieren waarop kritisch internetgebruik in het basisonderwijs geleerd kan worden. De onderzoeksvragen bij beide programma's waren:

- Hoe geven leerkrachten en leerlingen vorm aan het programma en op welke manier beïnvloeden contextuele factoren het realiseren van de intenties van het programma?
- Wat zijn de leerresultaten van de leerlingen in termen van kritische internetvaardigheden en vakinhoudelijke kennis?

Er is gebruik gemaakt van een case study design, om het functioneren van beide programma's zo gedetailleerd en omvattend in kaart te kunnen brengen. Beide programma's zijn uitgevoerd in vier verschillende klassen van verschillende scholen, teneinde relevante contextuele factoren op te sporen. Daarbij is gebruik gemaakt van verschillende manieren van dataverzameling: video-opnamen en geschreven observaties van de helft van de lessen, leerkrachtlogboeken van de overige lessen, interviews met leerkrachten en leerlingen, leerlingvragenlijsten, en computeropdrachten. De data-analyse was zowel kwalitatief als kwantitatief van aard.

In hoofdstuk 2 wordt het cursorische programma geëvalueerd in termen van de werkbaarheid van het programma voor leerkrachten en leerresultaten van leerlingen. Dit programma bestaat uit acht lessen van een dagdeel per week. Vijf lessen worden besteed aan het kennismaken en oefenen met de drie componenten van 'Web literacy' afzonderlijk; de laatste drie lessen zijn gericht op het geïntegreerd toepassen van deze vaardigheden in een opdracht. De leerkrachten hebben een uitgebreide handleiding tot hun beschikking, waarin alle lessen in detail zijn beschreven. De leerlingen werken met een werkboekje waarin voor elke les specifieke opdrachten en oefeningen zijn beschreven. Elke les begint met een klassengesprek en instructie van de leerkracht met betrekking tot de internetvaardigheid die die les aan de orde komt. Vervolgens gaan leerlingen in tweetallen aan het werk aan de computer. Daarna worden de oefeningen nabesproken in de hele klas, waarbij de nadruk ligt op problemen die de leerlingen zijn tegen gekomen.

Het programma blijkt dat in grote lijnen voor de meeste leerkrachten goed uitvoerbaar te zijn. De handleiding was daarbij van groot belang. Wel waren sommige lessen te lang, waardoor leerlingen de les niet in de gestelde tijd konden afmaken. Ook vormde de 'taligheid' van de lessen in het werkboekje een belemmering voor minder taal- en leesvaardige leerlingen. De lessen over het beoordelen van internetinformatie werden door leerlingen het meest gewaardeerd; de lessen over lezen op internet het minst. Zowel de setting als de leerlingpopulatie van de deelnemende scholen verschilden sterk. Vier groepen contextuele factoren blijken van belang te zijn bij de uitvoering van het programma. Allereerst de tijd en moeite die leerkrachten besteden aan zowel voorbereiding als uitvoering. Juist omdat het aanleren van kritische internetvaardigheden voor de leerkrachten een nieuw onderwijselement vormde, bleek een goede voorbereiding met behulp van de

handleiding heel nuttig te zijn, evenals de bereidheid om voldoende lestijd ervoor uit te trekken. Ten tweede was het gebruik van bepaalde didactische strategieën belangrijk, zoals het betrekken van de leerlingen bij opzet en doel van het programma en voldoende tijd uittrekken voor een klassengesprek waarin leerlingen ook zelf hun menig konden geven over bijvoorbeeld de noodzaak van het beoordelen van internetinformatie. Ook meer technische 'tools' zoals het gebruik van een beamer bleek belangrijk te zijn, omdat de leerkracht op die manier de leerlingen als groep goed kan betrekken bij zowel instructie als nabespreking. Ten slotte zijn er voorwaarden op klas- en schoolniveau te onderscheiden die van invloed zijn op het welslagen van het programma, bijvoorbeeld de sfeer in de klas en de manier waarop de computers op school zijn opgesteld. Een meer algemeen aspect dat van groot belang bleek te zijn was de 'onderwijsstijl' van de leerkracht en de mate waarin die stijl aansloot bij vorm en uitgangspunten van het programma. De leerkrachten die in staat waren om vorm te geven aan de meer constructivistische elementen uit het programma, zoals de samenwerking tussen leerlingen en het inbedden van instructie in klassengesprekken waren het best in staat de doelen van het programma te realiseren.

Wat betreft de leerresultaten van de leerlingen, is onderscheid gemaakt tussen resultaten met betrekking tot kennis van gezonde voeding enerzijds en kritische internetvaardigheden van de totale groep leerlingen anderzijds. Daarnaast zijn meer gedetailleerde gegevens verzameld over het toepassen van die internetvaardigheden van een geselecteerde groep leerlingen. In alle klassen blijkt de kennis van gezonde voeding en internetvaardigheden na afloop van het programma te zijn toegenomen. Die toename mag niet zonder meer toegeschreven worden aan het programma, gezien de lage betrouwbaarheid van de gebruikte toetsen en het feit dat het onderzoek een case-study opzet heeft, en dus geen controlegroep. Dat is met name van belang omdat leerlingen op deze leeftijd ook veel internetvaardigheden verwerven buiten school. Teneinde een indruk te krijgen van het vermogen van leerlingen om de verschillende kritische internetvaardigheden toe te passen in andere contexten, heeft een aantal leerlingen een zestal opdrachten gemaakt waarbij het accent lag op zoeken, lezen dan wel beoordelen van internetinformatie. Uit de resultaten blijkt dat leerlingen weliswaar in staat zijn om een aantal geleerde vaardigheden te gebruiken, maar dat hun internetgebruik daarnaast met name wordt gekenmerkt door inconsistentie: zowel tussen de verschillende opdrachten als binnen eenzelfde opdracht wisselen hun prestaties sterk.

In **hoofdstuk 3** wordt het onderzoeksgerichte programma op een vergelijkbare manier geëvalueerd. Dit programma kent weliswaar dezelfde leerdoelen als het

cursorische porgamma, maar andere uitgangspunten en een andere vorm. Het betreft een tien weken durend project waarin de leerlingen samen met de leerkracht onderzoeksactiviteiten onderneemt rond het thema gezonde voeding. Het leren zoeken, lezen en beoordelen van internetinformatie is ingebed in die activiteiten, die de eigen onderzoeksvragen van leerlingen als uitgangspunt hebben. De leerlingen werken toe naar een gezamenlijk eindproduct, een folder over gezonde voeding voor medeleerlingen en ouders. Die vragen hebben betrekking op drie deelaspecten van het thema. Vervolgens gebruiken de leerlingen internet om informatie te vinden over hun vragen. In zes achtereenvolgende weken wordt aandacht besteed aan de drie deelvaardigheden van kritisch internetgebruik, steeds gerelateerd aan de eigen ervaringen van leerlingen en het einddoel van het project: zelf een informatieve en betrouwbare folder te kunnen maken. De leerlingen krijgen zo inzicht in de functie en noodzaak van die vaardigheden.

Uit de evaluatie van het programma blijkt dat een dergelijke manier van werken zinvol is. Leerlingen worden tijdens hun onderzoeksactiviteiten geconfronteerd met de lastige kanten van internetgebruik en de noodzaak om daar mee te leren omgaan. Het programma bleek echter veel tijd, inzet en specifieke vaardigheden te vragen van leerkrachten. Net als bij het cursorische programma, is een aantal contextuele factoren van invloed op het welslagen van het programma. Allereerst hebben zowel leerkracht als leerlingen veel ondersteuning nodig met betrekking tot het formuleren van goede, 'werkbare' en voor internet geschikte onderzoeksvragen. Ook het samenwerken van zowel tweetallen leerlingen als de klas als geheel heeft aandacht nodig. In de klas waarin leerlingen goed samenwerkten en waarin kennis werd gedeeld met de hele klas, waren leerlingen het meest gemotiveerd en op de hoogte van kennis die door anderen werd aangedragen. Ten derde blijkt van belang te zijn in welke mate in de klas al aandacht is besteed aan verwerven van basale onderzoeksvaardigheden door leerlingen. Veel leerlingen waren op zoek naar het letterlijke antwoord op hun vraag, iets wat versterkt wordt door de veelomvattendheid en toegankelijkheid van internet. Ten slotte was ook bij dit programma de overeenkomst tussen de eigen stijl van de leerkracht en de uitgangspunten van het project van belang. Alle leerkrachten waren gewend aan werken met gezamenlijke onderzoeksactiviteiten aan de hand van leerlingvragen. Voor een deel van de leerkrachten bleek het programma echter op sommige punten te verschillen van hun eigen manier van werken, die meer uitging van spontane leerlingactiviteiten dan naar hun idee het geval was in het programma zoals beschreven in de leerkrachthandleiding. Ook de leerlingen hadden soms moeite met het verschil tussen hun eigen manier van internetgebruik en de gestructureerde opzet van het project.

De leerresultaten van het onderzoeksgerichte programma kwamen in grote lijnen overeen met die van het cursorische programma, zij het dat één klas geen vooruitgang laat zien wat betreft kennis van internetvaardigheden. Uit de analyse van de eindopdrachten blijkt dat ook de leerlingen die dit onderzoeksgerichte programma hebben gevolgd weliswaar in staat zijn om de in het programma aangeboden kritische internetvaardigheden te gebruiken, maar dat zij dat niet op consistente wijze doen.

In **hoofdstuk 4** worden een selectie van leerlingen van alle acht klassen die aan de programma's hebben deelgenomen, samen genomen ten behoeve van een nadere analyse van hun manier van werken tijdens de zes eindopdrachten na afloop van de programma's (N=21). Drie onderzoeksvragen staan daarbij centraal:

- Welke zoek-, lees- en beoordelingsstrategieën gebruiken leerlingen op internet?
- Hoe adequaat zijn die strategieën?
- Wat zijn de kenmerken van (in)adequate strategieën?

Deze dieptestudie is beschrijvend en explorerend van aard. Doel is een nadere bepaling van de vaardigheden die van belang zijn bij kritisch internetgebruik, als aanvulling op de literatuurstudie gepresenteerd in hoofdstuk 1. Daarbij is gebruik gemaakt van zowel kwantitatieve analyse (ten behoeve van de onderzoeksvragen 1 en 2) als kwalitatieve analyse (ten behoeve van onderzoeksvraag 3).

Het strategiegebruik van leerlingen laat zien dat zij vooral Google gebruiken als ze zelf vrij mogen zoeken op internet. Ze maken gebruik van zowel enkelvoudige als meervoudige zoektermen, afhankelijk van de aard van de opdracht. Lezen op internet wordt gekenmerkt door veel 'scannen' van teksten, op zoek naar een relevante passage. Daarnaast is er opvallend veel sprake van 'niet-lezen', wat bijvoorbeeld tot uitdrukking komt in het over het hoofd zien van relevante informatie of zelfs letterlijke antwoorden. Het beoordelen van internetinformatie gebeurt zelden, en alleen wat betreft de bruikbaarheid van de gevonden informatie; de betrouwbaarheid wordt niet spontaan ter discussie gesteld.

De adequaatheid van het strategiegebruik van de leerlingen blijkt sterk te verschillen, zowel tussen tweetallen als per tweetal tussen de verschillende opdrachten. Sterkere leerlingen (in termen van begrijpend leesvaardigheid) presteren niet altijd adequater dan zwakkere leerlingen, en presteren ook onverwacht wisselend. De al eerder genoemde inconsistentie is op die manier goed zichtbaar. Het is daarom zinvol preciezer te kijken naar welke internetvaardigheden leerlingen wel en niet laten zien. Met betrekking tot de zoekvaardigheden, blijkt dat leerlingen niet altijd goed letten op de juiste spelling van zoektermen. Ze zijn zeer wisselend in staat om relevante zoektermen op te stellen, wat vooral tot uitdrukking kwam bij de

meer complexe opdrachten. Leerlingen blijken zich vaak niet goed bewust te zijn van de manier waarop zoekmachines als Google werken; ze gebruiken spreektaal en overbodige woorden als lidwoorden. Wat betreft het lezen van internetinformatie blijkt dat de meeste leerlingen in staat zijn specifieke internet-gerelateerde leesvaardigheden te gebruiken, zoals het gebruik van een menu en links, het navigeren van websites en het scannen van internetteksten op trefwoorden. Tegelijkertijd lijken ze echter 'gewone' leesvaardigheden niet goed te gebruiken tijdens dat scannen of preciezer lezen van internetteksten. Bovendien blijkt de aard van de opdracht veel invloed te hebben op hun leesgedrag en op het resultaat daarvan. Ze zijn goed in staat informatie te vinden op een website waarvan ze vooraf weten dat het antwoord er te vinden is. Als ze zelf vrij zoeken op internet, lijken ze zowel minder goed gebruik te maken van specifieke internetelementen als een menu en links, als van meer algemene leesvaardigheden. Wat betreft de beoordelingsvaardigheden, blijken leerlingen redelijk tot goed in staat te zijn om elementen van het beoordelen van internetinformatie te benoemen en toe te passen op specifieke websites, als hen dat expliciet is gevraagd. Ze passen die vaardigheden echter niet toe bij het zelf vrij zoeken op internet, dus als er niet expliciet gevraagd is naar het beoordelen van de informatie. In dat geval lijken ze alle internetinformatie als gelijkwaardig te beschouwen, ongeacht de bron.

De vaardigheden van leerlingen vormen geen voldoende verklaring voor de adequaatheid van hun internetgebruik. Er blijken vier patronen ten grondslag te liggen aan (in)adequaat gebruik van internet. Flexibiliteit, ofwel het kunnen afwisselen van verschillende strategieën, is een belangrijk element van adequaat internetgebruik. Het feit dat veel leerlingen een soort 'vertrouwen' hebben in het vermogen van Google om voor hen het juiste antwoord te vinden, draagt niet bij aan hun flexibiliteit. Ook impulsiviteit (of juist geduld) blijkt van belang te zijn. Veel leerlingen zijn impulsieve internetgebruikers, zonder een duidelijk plan en met veel gebruik van 'trial and error'. Daarnaast is de neiging van veel leerlingen om te zoeken naar 'het precies goede antwoord' een belemmering voor een goed gebruik van internet. Ze zien daardoor vaak informatie die hen naar dat antwoord zou kunnen leiden, of relevante passages in wat andere bewoordingen over het hoofd. Ten slotte blijkt reflectie een belangrijke kwaliteit van goed internetgebruik te zijn. Het gaat dan om reflectief vermogen in relatie tot de specifieke eigenschappen van internet, met name het feit dat een gebruiker zijn of haar weg moet vinden in grote hoeveelheden ongestructureerde informatie. Reflectie heeft dan bijvoorbeeld betrekking op het bewust blijven van de eigen informatievraag en de gevonden informatie voortdurend relateren aan die vraag. Hoewel kinderen internet intensief gebruiken buiten de schoolsituatie, leren ze dergelijke reflectieve vaardigheden niet vanzelf.

Dat betekent dat het onderwijs op dat punt een specifieke, zij het niet eenvoudige taak heeft.

In de afsluitende **Conclusie en discussie** wordt terug gekomen op de probleemstelling en de onderzoeksvragen die richtinggevend zijn geweest voor het proefschrift. Daarnaast wordt een aantal meer overkoepelende punten besproken.

Een vergelijking van de evaluaties van de twee programma's laat zien dat beide in principe geschikt zijn om leerlingen kritische internetvaardigheden te laten verwerven. Er zijn geen duidelijke verschillen in leerwinst tussen beide programma's. Wel blijkt uit de evaluaties dat de klas die optimaal gewerkt heeft met het onderzoeksgerichte programma, een duidelijke voorsprong laat zien op een specifiek punt: de leerlingen in die klas blijken in staat de geleerde internetvaardigheden toe te passen op hun gezamenlijke doel, het maken van de folder. Ze geven blijk van inzicht in de functie van die vaardigheden, bijvoorbeeld door aan te geven dat je alleen maar een goede folder kunt maken als je zeker weet dat de informatie die je gebruikt, ook klopt.

Beide programma's zijn wat betreft het realiseren van de doelstellingen afhankelijk van een aantal contextuele factoren. Daarbij valt op dat de relatie tussen het programma en de stijl van lesgeven van de leerkracht bij beide programma's een belangrijke rol speelt. Beide sloten voor de deelnemende leerkrachten niet zonder meer aan bij hun gebruikelijke of geprefereerde manier van lesgeven. Beide programma's waren intensief en wat betreft leerdoelen nieuw voor de leerkrachten, wat van alle deelnemende leerkrachten veel vraagde en een dergelijke aansluiting van groter belang maakt. Met name bij het onderzoeksgerichte programma was daarnaast de sfeer in de klas van grote invloed op het verloop van de lessen, omdat samenwerking en het delen van kennis een grote rol in het project speelden. In niet alle klassen werd een onderzoeksgemeenschap gerealiseerd waarin die elementen goed uit de verf kwamen. In de klas waarin dat wel duidelijk het geval was, waren de leerlingen meer gemotiveerd en hadden zij een duidelijker inzicht in de functie en noodzaak van het verwerven van kritische internetvaardigheden.

Beide programma's hadden als uitgangspunt het integreren van het verwerven van kritische internetvaardigheden in de context van een vakdomein, in dit geval het thema gezonde voeding. De meerwaarde van een dergelijke integratie werd niet door alle leerkrachten herkend. Dat was deels een gevolg van het feit dat beide programma's wat betreft de leerdoelen een duidelijke nadruk kenden op de internetvaardigheden. Met name bij het cursorische programma bleef het thema gezonde voeding daardoor soms wat op de achtergrond. Bij het onderzoeksgerichte programma hadden leerkrachten moeite met het vinden van een balans tussen beide aspecten,

wat soms ten koste ging van de aandacht voor internetvaardigheden. Als het primaire leerdoel ligt bij het verwerven van vakkennis, kan het zinvoller zijn om internet in te zetten als een 'onderwijstool' en door bijvoorbeeld een selectie van geschikte websites die kennisverwerving optimaal mogelijk te maken.

Wat betreft de leerresultaten van de leerlingen laten met name de conclusies van hoofdstuk 4 goed zien hoe de interactie tussen specifieke eigenschappen van internet en de strategieën van leerlingen verloopt. Terwijl de overvloed aan gemakkelijk toegankelijke, ongestructureerde en ongeautoriseerde informatie op internet van de gebruiker reflectie, geduld en flexibiliteit vraagt, is dat juist niet de manier waarop kinderen internet benaderen en gebruiken. In vergelijking met de uitkomsten van het literatuuronderzoek gepresenteerd in hoofdstuk 1, valt op dat de nadruk die daar lag op de noodzaak van zoek- en beoordelingsvaardigheden, in onze resultaten enigszins is verschoven naar leesvaardigheden in combinatie met beoordelingsvaardigheden. Het goed en kritisch lezen van zowel de resultaten van zoekmachines als teksten op websites blijkt van doorslaggevend belang voor een adequaat gebruik van internet.

In de discussie wordt achtereenvolgens aandacht besteed aan de implicaties van het onderzoek voor de onderwijspraktijk en suggesties voor verder onderzoek. Van belang voor de onderwijspraktijk is allereerst dat in programma's die zich richten op het verwerven van kritische internetvaardigheden, een duidelijke nadruk moet liggen op kwaliteiten als reflectie en flexibiliteit, alsmede op het kritisch lezen op internet. Inbedding van dergelijke aspecten in de context van onderzoeksactiviteiten heeft daarbij als meerwaarde dat leerlingen gemakkelijker inzicht krijgen in de waarde en functie daarvan. Wel moet daarbij aandacht zijn voor een goede balans tussen inhoud en vaardigheden. Het leesonderwijs zou meer gericht moeten zijn op het gebruik van internet als bron van informatie. Traditionele methoden voor begrijpend lezen zijn gebaseerd op het begrijpen en beoordelen van gedrukte teksten. Internetleesvaardigheid kan niet geleerd worden uit een boek; bovendien gebruiken veel leerlingen internet naast of in plaats van boeken als bron van informatieve teksten. Dat vraagt om aanpassing van bestaande methoden.

Uit de evaluaties van de programma's blijkt ook dat het leren van kritische internetvaardigheden over langere tijd moet worden uitgespreid, bij voorkeur een schooljaar. Ook zou al eerder dan in de bovenbouw begonnen kunnen worden met leren kritisch om te gaan met internet, aangezien veel kinderen al op heel jonge leeftijd in de thuissituatie met internet aan de gang gaan. Op de pabo's en lerarenopleidingen zou bovendien ook expliciet aandacht besteed moeten worden aan het onderwijzen van kritische internetvaardigheden.

Naast deze praktische implicaties, komen uit het onderzoek twee vraagstukken van meer algemene aard naar voren. Allereerst is er met betrekking tot internetgebruik in het onderwijs sprake van een 'beschikbaarheidsparadox': internet is door zijn omvang en actualiteit een onderwijsmiddel dat goed ingezet kan worden voor activerend en zelfstandig leren. Juist die omvang en actualiteit nodigt leerlingen echter uit te denken dat elk antwoord en alle beschikbare informatie met weinig moeite en kant-en-klaar te vinden is. Ofwel: in plaats van actieve kennisbouwers worden ze passieve informatiezoekers. Deze paradox weerspiegelt deels de manier waarop in traditioneel onderwijs gewerkt wordt. Als van leerlingen een kant-en-klaar antwoord in zo kort mogelijke tijd wordt gevraagd, zullen ze daar op internet ook naar zoeken. Aandacht besteden aan het ontwikkelen van een onderzoekende houding alsmede het benaderen van leerlingen als actief en medeverantwoordelijk voor hun eigen leren kunnen daarom manieren zijn om met deze paradox om te gaan.

Een tweede, enigszins gerelateerd dilemma betreft het feit dat internet weliswaar ingezet wordt als onderwijsmiddel, maar door leerlingen vooral buiten het onderwijs wordt gebruikt. Veel leerlingen leren in eerste instantie thuis met internet om te gaan. In groep 7 beschouwen ze zichzelf als ervaren internetgebruikers. Hun manier van omgaan met internet sluit echter vaak niet aan bij wat op school van hen wordt gevraagd met betrekking tot internetgebruik, zoals eerst nadenken over wat je wilt weten en tijdens het zoeken voortdurend reflecteren op het eigen zoekproces. Dat betekent dat internet aan aantrekkelijkheid verliest zodra het voor school gebruikt moet worden. Leerkrachten hebben vervolgens moeite met wat zij zien als een oppervlakkige, passieve en 'gemakzuchtige' houding van leerlingen, omdat dat haaks staat op het actief opbouwen van kennis. Dit dilemma kwam ook naar voren in een deel van de klassen die werkten met het onderzoeksgerichte programma. Hoewel geen eenvoudig op te lossen probleem, lijkt het in ieder geval van belang te zijn om de vaardigheden van leerlingen serieus te nemen en aan te sluiten bij hoe zij met internet omgaan. In de onderwijssituatie zouden leerlingen vervolgens uitgedaagd moeten worden om andere internetvaardigheden te ontwikkelen.

Vervolgonderzoek zou zich moeten richten op een drietal gebieden. Allereerst is meer onderzoek nodig naar de manieren waarop kinderen en jongeren kritische internetvaardigheden kunnen verwerven. Bijvoorbeeld door longitudinaal onderzoek naar doorgaande leerlijnen op dat gebied en onderzoek bij leerlingen van verschillende leeftijden en schooltypen. Ook is het van belang om programma's waarin het verwerven van internetvaardigheden is ingebed in vakken als lezen en

wereldoriëntatie te vergelijken met programma's die expliciet op die vaardigheden gericht zijn. Docenten zouden bij dergelijk onderzoek moeten worden betrokken, bijvoorbeeld bij het ontwikkelen van programma's, omdat het succes van een programma mede van hen afhankelijk is. In de tweede plaats is meer onderzoek nodig naar de vaardigheden die leerlingen thuis verwerven, de manier waarop ze dat doen en de verschillen tussen internetgebruik thuis en op school. Ten slotte is het van belang om meer onderzoek te doen naar de verschillen tussen leerlingen met betrekking tot zowel het gebruik van internet als het leren van internetvaardigheden. Met name zwakke lezers zouden een groep kunnen vormen die minder gebruik kan maken van internetinformatie omdat dat veel complexe leesvaardigheid vraagt.

De resultaten van onderzoek naar internetvaardigheden en internetgebruik zijn noodgedwongen vrij vluchtig: zowel het internet als zijn gebruikers veranderen sneller dan onderzoek hen volgen kan. Met betrekking tot de bijdrage die onderwijs kan leveren aan kritisch met internet (leren) omgaan, is er echter sprake van een taak die wellicht minder onderhevig is aan verandering: ook leerlingen van de 'internet-generatie' hebben ondersteuning en aanmoediging nodig om informatie te kunnen omzetten in betekenisvolle kennis.

In Dutch

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